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THE MOST REMARKABLE ARMOR-PLATE TESTS thus far made at the Annapolis proving grounds were completed there this week. In our issue of May 16, 1891, tests of five plates of varying composition were described, two of which had been hardened by the Harvey process, which consists in so carbonizing the surface of the plate as to make it exceedingly hard, while the back of the plate remains soft and tough. In those tests the plates treated by the Harvey process showed small penetration, but were somewhat cracked. In the tests just concluded three Harvey plates were tested, made from a softer steel than that used in the previous tests, containing only 0.25% carbon, and a harder surface was given to them than in the plates before tested. Against each of these three plates, 14 rounds were fired from a Hotchkiss rapid-firing rifle using a 6-lb. armor-piercing projectile, which was delivered with a muzzle velocity of 1,911 ft. per second. The striking energy was sufficient for the shot to penetrate 4 ins. of common steel.

The results obtained were most astonishing. Every one of the projectiles was shattered when it struck the plate, and none of the plates were cracked or even penetrated to any depth, the projectile making only a slight indentation in the surface. This is an even better record than has been made by nickel steel plates treated with the Harvey process, and if similar results can be secured in service, nickel may not be used in the future American armor-plate.

THE BUREAU OF ORDNANCE, which has conducted the armor-plate tests thus far made, is said to intend to turn its attention now to the development of armor-piercing projectiles. Readers of JULES VERNE'S "Journey to the Moon" may remember his description of two great military rivals, one of whom was an inventor of armor-plates, and the other an inventor of guns. As fast as one would invent an armor-plate invulnerable to the other's highest power gun, his rival would bring out a new gun or projectile which would let daylight through the supposed unpierceable plate. The Ordnance Bureau proposes to follow the example of these two fictitious heroes; and now that it has an impenetrable armor-plate it proposes to design a projectile which will penetrate the plate. Instead of the ogival-headed projectile now in use for armor-piercing, a projectile is to be made with a blunt point. It is thought that this may also be of especial value in firing against a curved protective deck, where the present form of projectile is invariably deflected. Orders for a trial lot of projectiles of this form have been given to the Carpenter Steel Co.

THE GROSS EARNINGS OF RAILWAYS for the month of June and the first 6 months of 1891, as compared with those for the corresponding period of 1890, according to the *Financial Chronicle*, are as follows:

Period and No. Roads.	Mileage.		Earnings.		Increase p. c.
	1891.	1890.	1891.	1890.	
	Miles.	Miles.	$	$	
January (155)...	90,099	87,292	36,773,531	34,613,203	6.24
February (115)..	89,374	86,569	33,484,366	32,154,992	4.13
March (140).....	87,817	85,151	34,644,504	33,218,758	4.21
April (150).....	90,995	88,632	38,742,249	36,989,469	4.74
May (137).....	87,220	84,525	36,774,414	36,555,029	0.33
June (138).....	85,734	83,215	35,647,127	33,916,218	5.10

Considering the roads somewhat in detail, it is found that some of the separate systems have suffered heavy losses, but their number is small compared with those showing heavy gains. Of the total 138 roads, 15 show gains of over a quarter of a million, and 3 show losses greater than that amount. Unfortunately, the figures do not include several roads whose losses have been remarkably large. Prominent among these are the Chicago, Burlington & Quincy, the Pennsylvania and the Union Pacific roads, which for the five months ending May 31 exhibited decreases of $2,036,053, $2,010,696 and $639,868 respectively. Taken as a whole, however, the gain shown, both for the month and for the 6 months, over 1890 is very favorable, and shows that the transportation business, as a whole, has held its own in spite of unfavorable features affecting it.

THE LEARY LOG-RAFT, which left St. John, N.B., on June 28 is now at New York. This raft is the largest yet towed down and contains 3,500,000 ft. B. M. of lumber. The only mishap was the breaking in two of the raft during a storm off Bar Harbor. The connection was made again with some trouble and peril. This is the second raft, out of five attempts, that Mr. LEARY has succeeded in bringing to New York. We hear nothing of lights or signals on this unmanageable tow of about 4,000 ft. in length, and the query is a natural one as to what provisions are made to prevent collisions in case of fog, so common along this coast. The dangers to ships from the floating logs of the three wrecked rafts are apparent, and we believe that the French steamer *La Bretagne* thus lost a propeller blade in 1888. But the risk of crossing this long line of heavy rafts in foul weather is even greater, and it is time that some official supervision was insisted upon as to precautions against collision.

IMMIGRATION STATISTICS for the port of New York have been completed for the year ending June 30, 1891. These figures show that in this period 405,654 immigrants were landed at this port. Germany sent 7,382; Italy, 70,776; Ireland, 35,424; England, 24,229; Scotland, 4,908, and Wales 252. Russia sent us 33,504, the majority of whom were Jews. Sweden is credited with 29,415; Norway, 10,952; Denmark, 9,043; Hungary, 26,433; Austria, 20,539; Poland, 24,256, and Bohemia, 8,498. Of the Italians landing only 12,829 were women. As to distribution 18,270 were bound for Southern States, mainly Texas and Missouri. The majority of all the immigrants settled in the Middle States, New York alone taking 169,841. Pennsylvania comes next with 55,507. The number of unskilled laborers was 155,936. Of the remainder 40,459 were farmers. Only 510 immigrants were sent back, and these were nearly all Italians, 30 being contract laborers.

THE BOSTON RAPID TRANSIT COMMISSION gave a hearing on July 9 to the Boston Railway Co., which proposes to construct a series of tunnels connecting the various steam railways in and around Boston. About 5 miles of tunnels and 2 miles of approaches would be required. The estimated cost of the tunnels is $918,000 per mile, or about $5,000,000, and the approaches would probably add $1,000,000 more. The tunnels would be 17 ft. in diameter, be lighted by electricity, and be perfectly ventilated by a system of double tunnels. Access to the tunnels would be secured by inclines and electric motors used within them. The estimated capacity is 200,000,000 passengers annually. A viaduct plan, 3 miles long, from Dudley St. to the Causeway, was also submitted by Dr. H. L. BOWKER. The estimated cost for a 4-track road is $6,000,000 to $10,000,000, according to detail.

A PHOTOGRAPHER'S CAR has been added to the rolling stock of the Pennsylvania R. R. Co., fitted with a dark room and all the necessary appliances. The work to be done by this car will be a photographic survey of the country bordering the line of the road, under the general charge of Mr. W. H. RAU. The "survey" will be mainly in the line of the picturesque.

THE U. S. GEOLOGICAL SURVEY, under Director POWELL, will have $506,400 to spend for the fiscal year 1891-2. This sum is divided into salary and skilled labor, $15,000; topographic work, $296,200; geological work, $152,500; paleontologic work, $46,000; chemical work, $22,000, and for illustrations, reports, engraving, maps, etc., $91,700.

A MECHANICAL FUSE has been invented by Gen. BERDAN which utilizes the rotary motion of the shell when passing through the air and causes the shell to explode after a set number of revolutions. The mechanism is simple; with one screw and one small wheel the motion of the shell is reduced 1,200 to 1 by an arrangement of compound endless screws. A weight counteracts the tendency to turn the entire fuse around. A late test of two projectiles at Sandy Hook demonstrated the accuracy of the principle, and further trials are to be made.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the Colorado Midland R. R. at Aspen, Col., July 12. A special train of baggage car and one passenger car containing about 30 passengers was returning to Aspen from Glenwood Springs. The train was backing from the water tank on the switch to the Aspen track, where a road engine was run out of the roundhouse, and the rear end of the passenger train struck the engine, knocking off the check valve on the side of the boiler. This exhausted the hot steam into the broken end of the passenger car, scalding 13 passengers. Seven persons were killed.

BRIDGE ACCIDENTS are reported as follows: A wooden highway bridge across the Delaware River at Margaretville, N. Y., gave way under a crowd on July 4, throwing 12 persons into 5 ft. of water. One person was killed and 2 were more or less injured. A trestle on the Northern Pacific R. R., near Spokane Falls, Wash., gave way July 13 under a freight train, throwing 6 cars into the ravine. Two persons were killed. A bridge across the canal at Niagara Falls, N. Y., built by Rodgers & Clement, the contractors for the tunnel, for landing material, gave way under a small locomotive and 2 cars July 8. The Cuban mail train on the Jacksonville, Tampa & Key West R. R. was derailed on the Buffalo Bluff trestle, near Palatka, Fla., but was stopped before it reached the edge of the trestle. The connection between the drawbridge and trestle had been distorted by a heavy flood and steam, and had thrown the rail ends out of line.

A REAR COLLISION occurred at the entrance to the terminal station of the Northern Railway, at Paris, France, on July 12. An express from Calais, in connection with the Channel steamers from Dover, ran into another express train which was entering the station. Three cars were wrecked, and 14 persons injured, 4 of them seriously. The signal man admits that he omitted to signal the express train from Calais to stop, as he had become confused by the number of trains running in and out of this station.

THE INLAND WATERS of NEW JERSEY, from Cape May to Atlantic City, are being surveyed by Prof. R. A. MARR, of the U. S. Coast Survey. This survey will complete the record of the inland waters of our Atlantic coast, and the information thus gained may be of great assistance in case of war, for with a little deepening here and there torpedo boats could thus pass from point to point without going to sea. The work will probably be completed by Sept. 1.

Notes on Belgian Railways.

BELGIAN STATE RAILWAYS.

Belgium has about 3,250 miles of railway, of which about 2,000 miles are owned and operated by the state. This mileage is composed of a number of lines, over some of which there are run fast and heavy through trains to various parts of

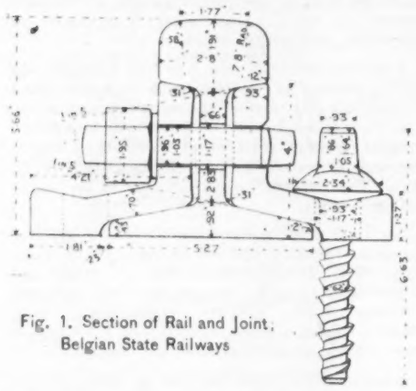


Fig. 1. Section of Rail and Joint, Belgian State Railways

Europe. The extensive offices of this system are at Brussels. The drawings from which the accompanying illustrations have been prepared were kindly furnished by M. BELPAIRE, the well-known engineer, to whom, as well as to several other members of the engineering staff, the writer is indebted for courtesies extended and for considerable information.

Track.—North of the frontier at Mons, on the through line from Paris to Brussels, there is a considerable stretch of track laid with Post steel ties, to which the rails are bolted. The rail joints are square and suspended, spliced by double angle bars and 4 bolts, with the nuts on the inner side. The bolts have T leads fitting into a groove in the outer splice bar. The ballast is of small broken stone level with the tops of the ties. The ties are rather rusty on top. Beyond this track the rails are laid on wooden ties in similar ballast, and are fastened by 2 spikes to each tie, and 2 at the end of the rail. Tie-plates are used at the joints. The rails are laid with square joints, spliced by plain splice bars with the

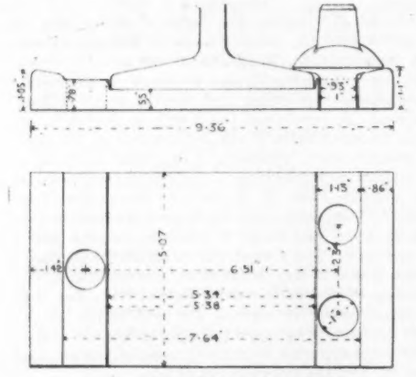


Fig. 2. Tie-plate; Belgian State Railways.

nuts sometimes on the inner and sometimes on the outer side of the rail. The track with steel ties makes very good riding, and there is less battering of the joints apparent with this than with the track on wooden ties with spike fastenings.

The standard rails are of flange section, 29 ft. 6 ins. long, weighing about 104 lbs. per yd., and being slightly modified from the Sandberg pattern. They are fastened to the ties by screw spikes, while ordinary spikes are used for the lighter rails. The rails are laid with square suspended joints, spliced by heavy angle bars 2.4 ft. long, with 4 bolts, the angle bars being fastened to the ties by screw spikes. The section at the joint tie is shown in Fig. 1, and on all the other ties a tieplate is used of the form shown in Fig. 2. There are 12 ties to a rail length, spaced 2 ft. at joint, and 2 ft. 4 ins. to 2 ft. 8 ins. intermediate. Some long angle bars with 4 bolts have been used, but were found more liable to crack at the top than the shorter plain splice bars used with light rails. Some of the rails in side tracks are very badly worn, and have pieces broken off the side of the head. The Grover nutlocks are said to be preferred by the trackmen to the Verona nutlocks. The wooden ties are of half-round section, with rail seats adzed out by hand. Square ties are used at frogs and switches. Belgian oak is preferred, being very hard. It comes principally from Luxemburg, but only one-third of the quantity required can be obtained, and no reforestration is provided for. American and Prussian oak are considered to be grown too fast in high country, with the result that the texture is not close enough and the wood is too soft. The spikes are of round section, with the narrow part of the T head bearing on the rail. They are driven into holes bored right through the tie, of the diameter of the blunt point of the spike, and the ties do not split. Flat tie plates are used with these spikes, having holes the diameter of the shank of the spike. With new track the spikes will begin to draw after a while, but when once redriven they remain firm, the whole track sinking or settling together to a bearing. The creosoted oak ties (3½ to 4 galls. of creosote per tie) cost about $1.10, while steel ties cost nearly twice as much in 1885, when steel was cheap. The ballast is of broken stone, in some places coarse and in others small.

Extensive experiments have been made with steel ties. In 1885-1886, 35,000 ties of the well-known Post type, designed by Mr. J. W. POST, Engineer of Maintenance of Way of the Netherlands State Railways, were laid; also 35,000 ties of the Braet type, a modification of the Post tie, and 3,000 ties of the Bernard type. Particulars of the experience with these ties were given in the writer's report on metal ties made to the U. S. Department of Agriculture in 1890. The earlier Post ties are said not to have given satisfaction, and some were being taken out last year, while all the Bernard ties had already been taken out. The Post steel tie and fastenings as used on these lines are shown in Fig. 3. They were made at the Angleur works in 1885, and the trouble experienced with them was that cracks started at the rounded curves of the punched bolt holes, to obviate which Mr. POST'S latest pattern of tie has oval drilled holes, but none of these are in use on these lines. The ties weigh 165 lbs. each. Near Antwerp a section was inspected on which one track was laid with Post steel ties and the other with wooden ties. The removal of some of the bolts of the former showed the cracks referred to, and also a wear of the tie by the rail flange. On digging up the ballast it was seen that water remains under the ties, and causes mud to form around them, while on the other track the ballast was dry. The ballast is of porphyry, broken quite small, and consisting mainly of flattish pieces. The wear of rails is found to be about the same on steel and wooden ties. In a yard at Antwerp for the storage of track material were seen a number of steel ties with a crack at the middle starting at the lower edge and running up the side. This was explained as due to a defect of the metal.

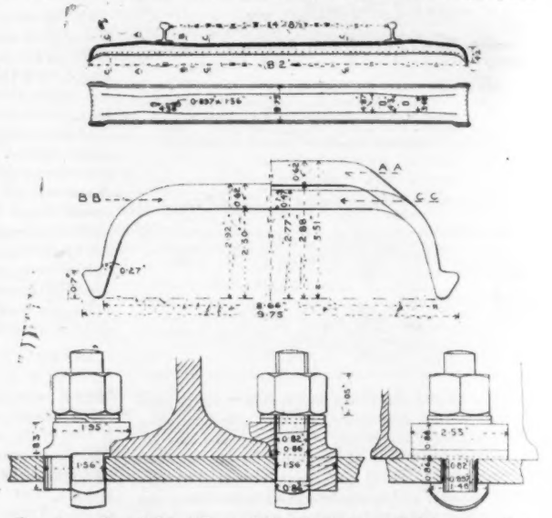


Fig. 3. "Post" Steel Tie and Rail Fastenings; Belgian State Rys.

The line is equipped with block signals of the English semaphore pattern, supplied by Saxby & Farmer, of London. At the extensive yards at Mons the signal blades have the name of the track painted in black letters. Two systems of block operation are in use, one Belgian and one English. The grade signs are of iron, with white letters on a black ground. At the approach to a single-track tunnel the trains slow down to take on an official who rides through and gets off at the other end, the arrangement being practically that of the train-staff system. The station at Malines has a large arch roof springing from the rail level, but the side of the building is at the back of the arched ribs, so that the latter project out on the platform and form numerous corners for dust and rubbish to collect. It was stated that the roof had been designed by an architect, and was made very much too strong. There are numerous road crossings, all having a watch man or woman, with a house at the side of the track and a gate or bar across the road. The line approaches Antwerp on the level, but on account of the number of road crossings the railway is to be elevated about 13.12 ft., and a new terminal station built. At Antwerp are very extensive freight yards and warehouses, with hydraulic power for cranes, capstans, etc. Some of the bridges on this line have iron-plate floors.

Locomotives.—The standard types of engines are shown in Figs. 4 to 9, and their dimensions are given in the following table. There are three types of freight engines, with 6, 8 and 10 wheels, the trailing wheels of the latter not being coupled. The two types of engines with eight coupled wheels are used on the steep grade of 1 in 30 (3.33%) near Liege, and on the line between Pepinster and the frontier of Luxemburg, which has grades of 1 in 37 (2.7%). It will be noted that for express trains on lines with steep grades, engines similar to the American "mogul" type are used. Inside cylinders are inclined when the leading wheels are coupled, and the valves are placed between the cylinders and the

DIMENSIONS OF LOCOMOTIVES.

	PASSENGER.			FREIGHT.		
	Fig. 4.	Fig. 5.	Fig. 6.	Fig. 7.	Fig 8.	Fig. 9
Cylinders.....ins.	20 × 24	20 × 24	14 × 20	20 × 24	19.2 × 22	20 × 22
Diameter of driving wheels.....ft.	6.89	5.57	3.93	4.26	3.44	3.41
" boiler.....ft.	4.26	4.6	3.5	4.6	4.6	4.9
Tubes, number.....	242	236	147	251	251	242
" length.....ft.	12 63	13.3	8.3	11.5	13.12	13.15
" diameter (outside.).....ins.	1.8	2	1.8	1.8	1.8	1.8
Heating surface: tubes.....sq. ft.	1,207.0	1,412.0	497.0	1,176.6	1,340.0	1,452 6
" " firebox.....sq. ft.	134.5	161.4	72.8	122 0	121.5	141.0
" " total.....sq ft	1,341.5	1,573 4	569.8	1 298.6	1,464.5	1,593.6
Wheel base: driving.....ft.	7.08	14.10	13.12	13.78	14.76	14.76
" " total.....f..	21 51	21.81	13 12	13 78	14.76	23.71
Weight on 1st axle.....tons	11.5	12.2	10.2	14.6	13.1	14.7
" 2d axle.....tons	13.3	12.6	10.7	14.8	13.0	14.7
" 3d axle.....tons	12.9	15.0	9.8	13.8	13.6	15.2
" 4th axle.....tons	11.3	13.3	...	....	12.7	15.3
" 5th axle.....tons	....	....	....	....	....	15.1
" total.....tons	49.0	53.1	30.7	43.2	52.4	75.0
Water.....U. S. galls.	....	....	....	....	1,742	2,904
Coal.....lbs.	....	....	....	....	4,180	9,500

frames. The Walschaert valve gear is used, and although it appears complicated is found very satisfactory in service. Deep plate frames are used, the middle frame being bolted to the cylinder casing. These frames are of iron, as steel is dear in Belgium. Some of the later engines have smokestacks of square section, with the sides flaring out to give

connected by equalizing levers. The fireboxes are of copper, and have an average life of 12 years without repair, and can then be patched, which it is claimed cannot be done with steel. In the boiler shop at Brussels was seen a copper firebox which had been in service 13 or 14 years, and was having its first repairs made, consisting of a new tube plate

and Brussels are fitted with the vacuum brake used by the Northern Ry. of France. These engines make a great noise of blowing off steam when creating the vacuum. The boiler, cab, wheels and tender are painted a dark chocolate brown, the boiler having brass hoops. The firebox, smokebox and smokestack are black, and the latter has a brass

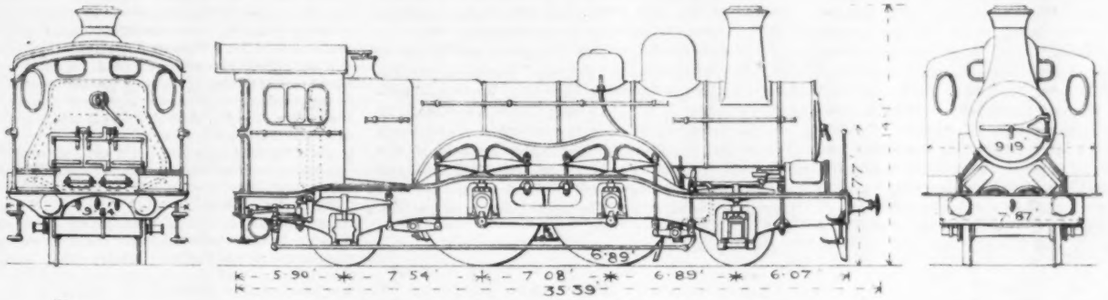


Fig. 4. Passenger Engine for Level Lines.

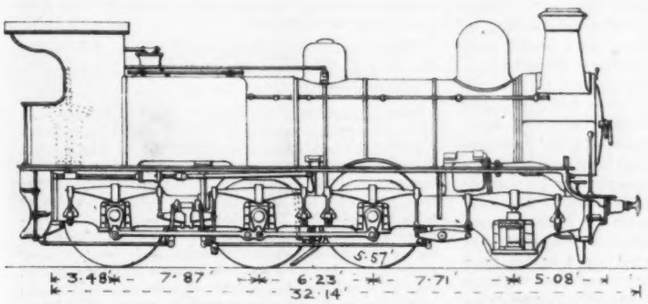


Fig. 5. Express Passenger Engine for Lines with Steep Grades

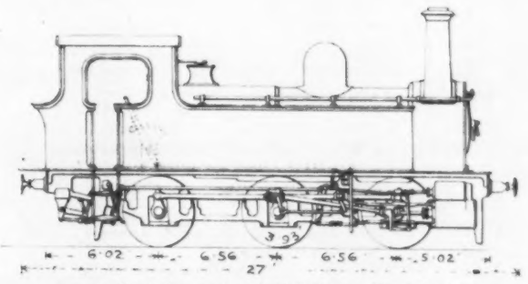


Fig. 6. Tank Engine for Light Trains on Steep Grades.

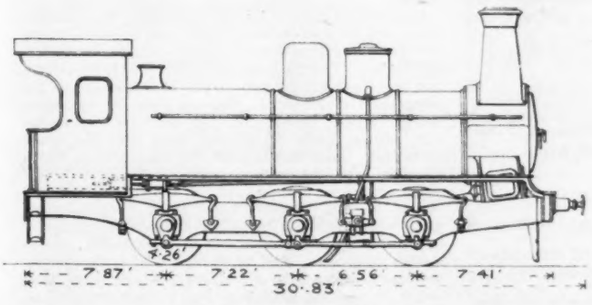


Fig. 7. Freight Engine.

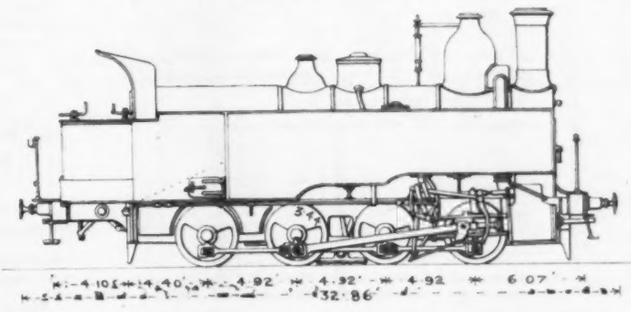


Fig. 8. Tank Freight Engine.

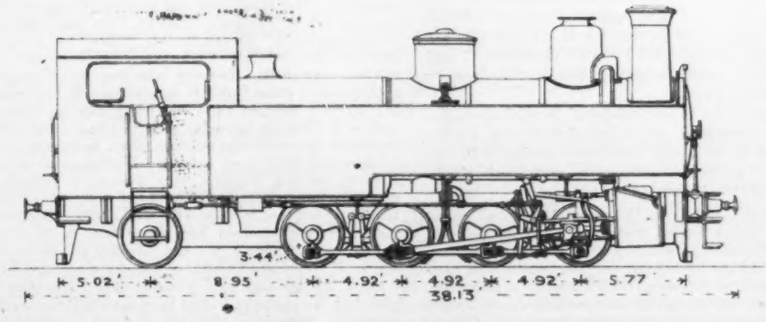


Fig. 9. Tank Freight Engine.

STANDARD TYPES OF LOCOMOTIVES; BELGIAN STATE RAILWAYS.

a very wide opening at the base of the stack, where wire netting is placed to arrest sparks. The domes and sandboxes are of large size. The fireboxes are of the Belpaire type, and some of them are so wide as to extend over the frames. Some of the engines have coupling rods of I-section with solid ends. Trucks are not used, but the leading wheels of express engines have radial axles. The driving wheels have laminated springs, curved the reverse way to the usual form, and are

and some new staybolts. Coal briquettes are not used for fuel. The tubes are usually of brass, but iron is used in some cases. For boiler repairs, the boiler is carried on a machine which revolves it, making every part easy of access. At the Brussels works is a machine for taking the weight on each wheel of an engine. The tenders have generally four wheels. The Westinghouse brake is used, but the engines which haul the through Paris and Brussels trains between Mons

molding on top. The frames are Indian red, with vermilion and black striping. A combined engine and car is used for local military service around Antwerp. No engines are built at the works of the State Railways, the law requiring that they shall be purchased from manufacturers. The workmen in the repair shops must be Belgians.

Rolling Stock.—A few cars and saloons used in the transcontinental service are carried on trucks or "bogies." Long freight cars are also carried on trucks, and for long pieces of freight are preferred to two ordinary short cars. Some of the first class cars have coupé ends, with a seat on one side only and windows in the end. Some of the third class cars have end platforms and doors. The outside sheathing is sometimes of vertical strips of Indian teak, well polished. Local trains near Antwerp are made up of short cars on 4 wheels, with iron underframes and end platforms fitted with gates. The body has end doors and a middle gangway, but is divided by partitions and doors. The seats are placed facing one another, as in ordinary compartments, and seat 2 passengers on each side of the gangway. A military train for the exclusive accommodation of the troops at the forts around Antwerp is run at certain intervals, the government paying the expenses. It consists of a combined engine and car, built on an iron frame. The car is divided into two compartments, for officers and privates, and has under the

floor a box or compartment for dogs. The car is handsomely fitted and has the interior finished in natural wood, with sofa seats upholstered in crimson. When more soldiers are to be carried than the combination car will carry, one of the third-class cars above described is attached. A second-class car of a Dutch railway attached to a train from Brussels to Antwerp was comfortably upholstered in bronze plush, with high padded back and arm and head rests in the middle of the seat. The floor was covered with a cocoanut mat, and the ceiling was painted cream color, with brown moldings. The door and window frames were of mahogany. In each compartment was a little red box, not unlike a messenger call box, with a lever projecting from the top, by means of which the passengers could apply the Westinghouse brake in case of emergency. In each compartment were painted in 4 languages various instructions to travelers. The car was carried on 4 wheels and divided into 4 compartments. It was

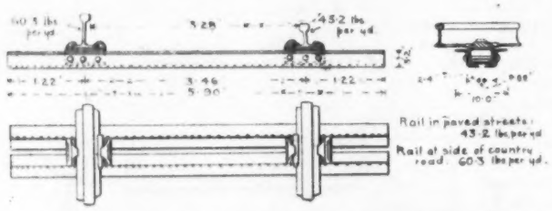


FIG. 10. Z-BAR STEEL TIE; CHARLEROI LOCAL RAILWAYS, BELGIUM.

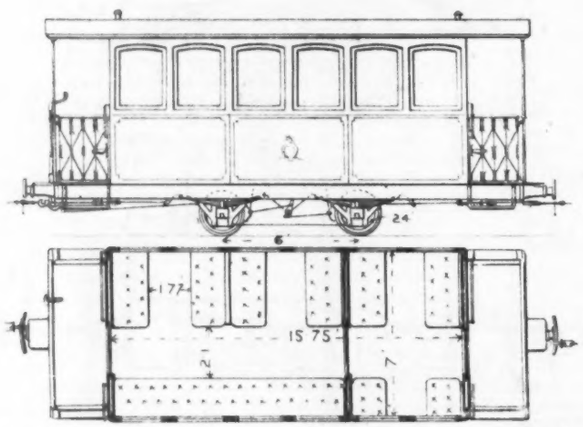


FIG. 11. PASSENGER CAR; CHARLEROI LOCAL RAILWAYS, BELGIUM.

painted a dark brown with red frame. Statistics of the Belgian State Railways show that the percentage of seats occupied in the different classes on ordinary trains and on express trains, on which the fares are 25% higher, was as follows:

	First class.	Second class.	Third class.
Ordinary trains	8%	22%	30%
Express trains	20%	35%	18%

CHARLEROI LOCAL RAILWAYS.

The Société Anonyme des Railways Economiques, which owns local railways in different parts of Belgium, has three lines near Charleroi. These lines run to Mont sur Marchienne, 1.86 miles; to Lodelinsart, 2.17 miles, and to Martigny le Tilleul, 4.96 miles. The first has a curve of 115 ft. radius on a grade of 2%, and has grades of 3.8 and 4.7%. The second has curves of 82 to 115 ft. radius and grades of 3.2 to 5.5%. The third has curves of 82 ft. to 102 ft. radius and grades of 3 to 4.7%. The first two lines have each one train in service, making 15 trips each way per day. The third line has 3 trains in service, making 30 trips each way per day.

Track.—The lines are of meter gage, and are laid with flange rails on the Z-bar ties invented by M. Willemin, of Brussels, and manufactured by the Société Anonyme de Marcinelle et Couillet. These ties, together with a visit to the Couillet works, were described in Engineering News, Aug. 9, 1890. In paved streets the rails weigh 60.3 lbs. per yd., and along the side of country roads they weigh 43.2 lbs. per yd. In the latter location the ties are bedded in cinder ballast. M. Lariollette, the Director had this ballast dug up on a part of the track that had not been disturbed for three years. The ties were found to be in good condition, and the iron key fastenings perfectly tight. Each tie, consisting of 2 steel Z-bars, 2 chairs, 2 keys and 6 rivets, weighs 115 lbs. and when filled with ballast weighs 194 lbs. One of these ties is shown in Fig. 10.

Locomotives.—There are 9 engines, all boxed in like the locomotives or "dummy" engines generally used on steam tramways. They have horizontal outside cylinders 11.28 × 14.8 ins.; 6 coupled wheels, 32 ins. diameter and 35 ins. c. to c. of axles. The wheels are inside the frames. The valve gear is of the Walschaert type. The boiler pressure is 135 lbs. per sq. in. The engines weigh 15 tons empty and 17.5 tons in working order. The maximum speed authorized is 12.4 miles per hour.

Rolling Stock.—The passenger equipment consists of 8 first-class and 14 second class cars. They have end platforms and are not unlike street cars, as shown by Fig. 11. The cars having wide platforms are 23.6 ft. and those with short platforms 22.3 ft. over the buffers. The wheels are 24 ins. diameter. The first-class cars are divided into two compartments, one for 6 passengers and the other a smoking compartment for 14 passengers. The second-class cars have seats for 24 passengers. The couplings consist of links connected by a screw, and attached to hooks on the ends of the drawbars, being drawn tight by a handle on the screw. No safety chains are used. Each car weighs about 3 tons empty.

E. E. R. T.

The Production of Phosphate of Lime.

II.

(*Continued from page 39.*)

THE PHOSPHATE DEPOSITS OF SOUTH CAROLINA.

The chief source of phosphate of lime in the United States at present is the phosphate beds of South Carolina. The rocks obtained is that classed by Dr. Penrose as "amorphous nodular phosphate," and it is similar in many respects to the English deposits described last week.

A writer in the *Manufacturers' Record* gives the following account of the original discovery and development of the South Carolina deposits by Dr. N. A. Pratt, a native of Georgia, and Prof. F. S. Holmes, of Charleston.

During the Civil War Dr. Pratt was in the staff corps, Nitre and Mining Bureau, under Col St. John, actively engaged in hunting up such sinews of war as lead, iron, nitre, etc. At the close of the war Dr. Pratt, then resident in the city of Augusta, Ga., determined to seek some base of supply from which he could begin the manufacture of the super-phosphates—commercial fertilizers. Following up this idea he went to Charleston, S. C., and consulted Prof. Holmes as to the fossils found in the vicinity of the city, and was told by Prof Holmes what he knew of the same and that such analyses as had been made and were known to him showed only 30% to 35% phosphate of lime. The interview led to an examination being made by both gentlemen, and having collected samples they each made two analyses. Pratt's first analyses was 6%, his second 7%, and the two made by Prof. Holmes ran about the same.

As scientific and well-posted men they were each alive to the great importance of the discovery they had made. But the money to make practical use of it was not in their possession, nor could they expect to raise the same at the South in her then impoverished condition on any kind of security or promise of the expected golden harvest from working these beds.

However, both Pratt and Holmes proved equal to the emergency. So, procuring a sack full of samples, they at once quietly journeyed to the city of Baltimore, where Dr. Pratt made known, in confidence, his discovery to an acquaintance and capitalist—a man whose name has since been a power in the fertilizer trade. The Baltimorean, after taking two or three days to consider, declined to take an interest in the enterprise. The result was Dr. Pratt and Prof. Holmes proceeded to Philadelphia, where the samples were shown to the Messrs. Lewis Bros., of South Front St. These gentlemen had their chemist make an analysis. They then declared themselves satisfied and offered to invest, and that very day gave their check to Pratt and Holmes for $10,000, the full amount, as these gentlemen supposed, necessary to purchase all of the known deposits, upon the verbal understanding that of all purchases made Lewis Bros. should have one-half interest for the money advanced, and Pratt and Holmes one-fourth each as compensation to them for their knowledge of discovery.

Returning at once to South Carolina, the purchases were made, and in 1868 the phosphate lands so purchased were merged into an incorporated company, capitalized at $400,000 (the South Carolina Mining Co.). The stock of this company was soon at par, at which point Prof. Holmes sold out. Afterward it was much depreciated, as new discoveries were made much faster than the trade demand was generated for the product. But this same original stock is now probably worth from 5 to 8 to 1 on the original capitalization.

These phosphate beds are described as follows by Dr. R. A. F. Penrose, Jr., in Bulletin No. 46, U. S. Geological Survey:

Nodular phosphatic deposits are found at intervals all along the Atlantic coast of the United States from North Carolina down to the southern extremity of Florida, but the richest beds occur in South Carolina, in a strip of country running from Broad River 60 miles along the coast in a northeast direction. The belt has a width of from 10 to 20 miles. The phosphate does not occur continuously over this region, but in patches, sometimes having an area of many square miles and again only covering a few acres. In this whole area of more than 900 sq miles, the hills rarely rise to a height of over 10 to 15 ft. above high-water level, and the country is cut up into islands and peninsulas by the numerous tide-water inlets and creeks.

The tertiary deposits form a fringe along the Atlantic coast and the Gulf of Mexico from New Jersey to Texas, but are best developed in the central portion of this extensive belt. The Claiborne marls, the Santee buhrstones and lime-stones and the shell sands of Alabama are the lowest beds of this series. Beneath them lie the Pedee marls, which belong to the secondary formation and contain fossils resembling those from the chalk of Europe. Immediately over this formation in South Carolina are the eocene marls. These beds are very extensively developed in that state, and are called by Mr. Ruffin "the great Carolina marl bed," which is divided into three divisions, known, in an ascending order, as the Santee River, Cooper River and Ashley River beds. The whole formation is about 700 ft. deep and contains 55 to 95% of carbonate of lime. It is one of the most important marl beds in the world, both on account of its extent and its agricultural value.

The upper part of the Ashley marl contains a great number of fossil shark teeth and cetacean bones, and has been called by Professor Tuomey "the fishbed of the Charleston basin." Overlying this "fishbed" is a deposit of sands and clays of very irregular thickness and containing many shells. The bed sometimes runs out altogether and at other times is several feet in thickness.[1] It is directly overlaid by a bed containing many shark teeth and cetacean bones, as well as the remains of the mastodon, megatherium, elephant, deer, horse, cow, hog, muskrat and other land animals. Besides these animal remains, the bed contains very numerous irregularly shaped nodules containing 25 to 70% of phosphate of lime. This is the bed that is worked for phosphates. Sometimes the underlying stratum has not existed or has been eroded, and the nodule bed rests directly on the eocene marls. It is composed mostly of nodules, associated with a much smaller and very variable quantity of bones of land and sea animals, buried in a matrix of a variable character. Sometimes they are in a bed of highly siliceous sand, containing many flat pebbles of white quartz; at other times the matrix consists of ordinary clay or of sand and clay mixed. A light blue or green clay is also often seen.

The nodules are of very irregular shape, and vary from the size of a pea to that of a mass weighing a ton or more. The larger masses, however, are often composed of a number of small nodules cemented together. The nodules, like those of England and of France, are all more or less waterworn and rounded and are much bored by marine animals. The nodules vary in hardness from 2 to 4 and have a specific gravity of 2.2 to 2.5.[2] When a fragment is rubbed, or, better, when two fragments are

[1] F. S. Holmes: The Phosphate Rocks of South Carolina.
[2] Dr. C. U. Shepard, Jr.: South Carolina Phosphates.

rubbed together, they give off an odor of decayed organic matter.

The nodules are found on the bottoms of most of the rivers running through the phosphate district, having been washed out of their original beds. These river deposits in many cases have proved to be of great commercial value. The nodules are, as a rule, of a much darker color than those of the land and are often black.

The nodule bed varies in thickness from a few inches to about two feet and a half, the average being about 7 to 9 ins. It is only when the nodules are found in a pocket or depression in the underlying marl that the thickness reaches much over 2 ft., and even under such circumstances such a thickness is of very rare occurrence. The yield of phosphate per acre varies, not only with the thickness, but also with the compactness of the nodular stratum, as sometimes the nodules are packed as close as cobblestones in a road, while at others they are scattered loosely in the sand or clay matrix. The average yield of clean, dry phosphate is 300 to 1,200 tons per acre.

Under the city of Charleston the phosphate bed is found at a depth of over 60 ft. Where the bed does not appear on the surface it is covered by alluvial deposits, consisting of clay, sand or marl, or of strata of all three. Occasionally there is a stratum of highly ferruginous sand or gravel, sometimes indurated into a regular "hard-pan," directly overlying the phosphate bed, and from 1 to 10 ins. thick. Sometimes this ferruginous substance has penetrated the whole bed to a depth of several inches and cemented the upper nodules into a solid mass; while the lower part of the bed is much looser and more easily mined. Again, the sand overlying and intermixed with the nodules has sometimes been cemented together, especially in river bottoms, by the action of soluble silicates. Such has been the case with the phosphate in parts of the Stono River. Here the nodules have in some places been completely permeated by silica, and form a solid floor on the river bottom.

MINING THE LAND DEPOSITS OF PHOSPHATE.

The phosphate nodules are obtained both by digging on the land and by dredging in the river bottoms. Dr. FRANCIS WYATT, in the *Scientific American*, describing the methods in use in exploring and working the land deposits, says that after making a careful topographical survey of the tract to be explored, borings are made at intervals of 100 feet all over the tract.

The results obtained from the borings are verified and confirmed by a series of exploratory pits, 10 ft. × 5 ft., which are dug at intervals of 500 ft. The bore holes are driven to a maximum depth of 15 ft., and no pits are at present sunk on those portions of the land where at that distance no phosphate has been encountered. Immediately after removing the overlying strata the phosphate is carefully removed, its depth and thickness measured, and an average sample of the rock and nodules secured and laid aside for analysis.

So far as I have been able to discover, no systematical investigation has been made of those lands which contain the phosphate deposit at a greater maximum depth than 15 ft., it having been hitherto considered impracticable under present conditions of abundant surface supply, and consequent low mining cost, to conduct a profitable exploitation at any greater depth. A far wider area of lands than those actually classed as mining properties may contain the very same deposit of phosphate, lying under a considerably greater accumulation of the quaternary strata. I am quite disposed to adopt this view as representing the facts, and do not hesitate to predict that means will soon be found of turning them to good account.

In mining the phosphate from a tract, it is customary to establish a main trunk railroad starting at the river front or on the bank of some convenient stream, and passing right through the center of the property to be exploited.

Alternate laterals can be run off at right angles from any portion of this main line, at distances of say 500 ft., in conformity with the nature of the ground. Between and parallel to these laterals, a ditch or drain is dug to a depth extending 4 or 5 ft. below the phosphate strata. From this main drain the excavators start their lines at right angles to the laterals, commencing at one end of the field and digging trenches 15 ft. wide and 500 ft. long, the work being so arranged that the men are stationed at intervals of 6 ft. Every man is supposed to dig out, daily, "a pit" 6 ft. long, 15 ft. wide, and down to the phosphate rock. The overlying material is thrown out to the left-hand side of the trench. The phosphate itself is thrown out to the right, and taken in wheelbarrows to the railroad cars which pass at either end of the trench. The water drains from the trenches into the underlying ditch, and is thence pumped out by means of a pump worked by steam from a locomotive engine. The pump and the engine are secured to connected railway platforms, and run along the railroad track, from one ditch to another, as occasion requires. The cars, loaded with the crude phosphatic material dug out of the pits, are run down to the washing apparatus, constructed at an elevation of some 30 ft. from the ground, and generally consisting of a series of semicircular troughs 20 to 30 ft. long, set in an iron framework at an incline of some 20 ins. rise in their length.

Through every trough passes an octagonal iron-cased shaft, provided with blades so arranged and distributed as to form a screw with a twist of one foot in six, which forces the washed material upward and projects the fragments against each other. The phosphate-laden cars are hauled up an incline and their contents dumped into the bottom trough, where the phosphate encounters one or more heavy streams of water, pumped up by a steam pump. This water does not run off at the bottom, but overflows at the higher end near where it enters. When sufficiently washed, the phosphate is pushed out upon a one-half inch mesh screen; the small debris being received on oscillating wire tables below. It is now ready for kilning or drying, and of all the methods hitherto adopted for this important process that of simple burning or roasting, in an ordinary kiln, such as is generally used in the manufacture of bricks, has been found at once the most rapid, effective and economical.

The rock is built on layers of pine wood, and owing to its containing a considerable quantity of organic matter it readily lends itself to combustion and requires but a short time to become quite red hot. The kilns are made sufficiently large and so arranged as to allow free passage to a train of cars, which, running on the main line of railroad, can be loaded in the kiln, run down to the landing place and discharged directly into the barges or boats on the river.

With a properly constructed plant, regular drainage and efficient management, the total cost of producing one ton of South Carolina phosphate in clean, dry, marketable condition is about $3.50, made up as follows:

Mining, at a maximum depth of 15 ft	$1.00
Draining the mine	.25
Loading on cars and carrying to washer	.70
Washing	.30
Drying and handling in kiln	.50
Shipping from kiln into vessels on river	.25
Interest on capital invested in plant and repairs to same	.15
Superintendence and management of mines	.20
Towage to Charleston, say	.25
Total per ton of 2,240 lbs	3.50

Dr. PENROSE says that it does not usually pay to remove more than 8 or 9 ft. of overlying earth. Steam excavators were tried at one time by the Pacific Guano Co.; it is not known with what success. The nodules are broken in pieces not over 5 ins. in diameter before passing through the washer. Several different kinds of washers are used besides the one described by Dr. WYATT. Drying the nodules requires 35 to 40 cords of wood for each 1,000 tons of nodules, and the process requires 33 to 40 hours.

RIVER MINING.

Dr. PENROSE describes the system employed here as follows:

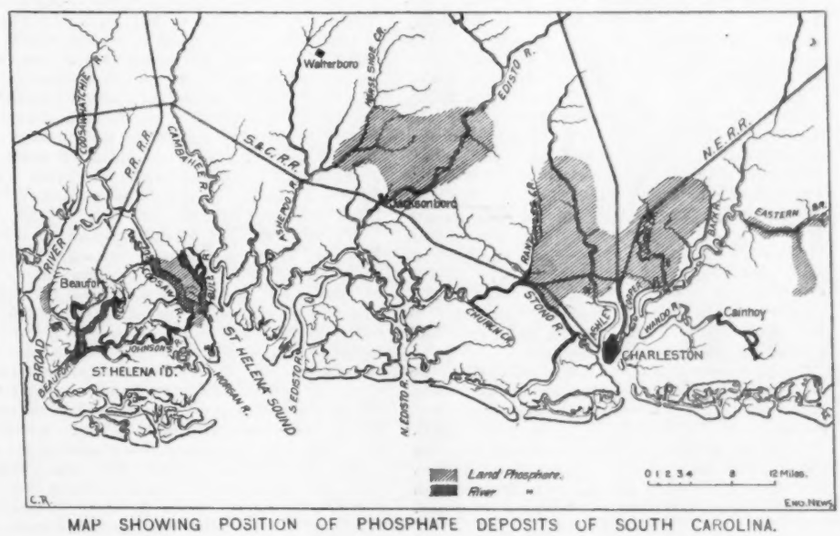
The nodules in the river bottoms are now obtained by dredging-boats, though a few years ago large quantities were obtained by negro divers and with oyster tongs. The dredging scoops have to be very strongly built in order to break through the nodular stratum. The boats are held in position at the four corners by strong "spuds" with iron points. The nodules are thrown from the scoop of the dredge into the washer, which is on a lighter alongside the dredging boat. The washer in some cases is the same as those used by the land-mining companies; but often it consists of a truncated cone, with perforated sides, revolving on a horizontal axis. It is supplied on the inside with steel spirals arranged around the side like the grooves in a rifle. Into both ends of the cone heavy streams of water flow. The nodules are dumped by the dredge into the small end of the cone, and come out at the large end. They are then removed by a derrick to another lighter and towed to shore.

Clam-shell dredges and endless-chain dredges have been used, but the dipper dredge is the most common.

CHARACTER OF THE PRODUCT.

Averages of several hundred analyses by Dr. C. U. SHEPARD gave 25% to 28% of phosphoric acid, equivalent to 55% to 61% of bone phosphate of lime. Analyses of a large number of samples by Dr. WYATT showed an average of 57.63% of phosphate of lime. Dr. PENROSE says:

The deposits of South Carolina, although of low grade compared with some others, are now more generally used than any other known phosphate. The output of the mines, which is yearly increasing, is shipped to the North, South and East by sea and to the West by rail. This popularity is due not only to the cheapness of the phosphate [now $5 to $7 per ton], but to the many good qualities of the low-grade acid phosphate made from it. The fact that the nodule bed extends, at an accessible depth, over many miles of country, the easy approach for large vessels up to the very mines, the abundance of water, fuel and labor, and a climate that permits mining operations to be carried on throughout the whole year, all combine to make the South Carolina phosphates the cheapest and consequently the most productive source of supply of this material.



MAP SHOWING POSITION OF PHOSPHATE DEPOSITS OF SOUTH CAROLINA.

STATISTICS OF PRODUCTION.

The following table, taken from the *Manufacturers Record*, shows the total number of tons of phosphate mined in each year since the starting of the industry:

Year.	Land rock.	River rock.	Total.
1868-70	18,000	1,989	19,989
1871	33,000	17,655	50,655
1872	38,000	22,592	60,592
1873	45,000	45,777	90,777
1874	43,000	57,716	100,716
1875	48,000	67,939	115,939
1876	54,000	81,012	135,912
1877	39,000	126,569	165,569
1878	113,000	97,700	210,700
1879	102,000	98,586	200,586
1880	125,000	65,102	190,102
1881	141,000	124,541	265,541
1882	190,000	140,772	330,772
1883	276,000	129,318	405,318
1884	758,000	151,243	409,243
1885	224,000	171,671	395,671
1886	294,000	191,191	485,191
1887	330,000	202,737	532,737
1888	260,000	193,274	453,274
1889	250,000	212,101	462,101
1890	300,000	237,149	537,149
Total	3,031,000	2,434,557	5,465,557

At the average selling price of this rock—$5 per ton—the value of the crude rock already mined has been $32,793,342.

About 30 companies are engaged in mining, with a total nominal capital of about four and one-half million dollars. Nearly all the river rock is shipped to Europe. The land rock is largely used by local manufacturers of superphosphate. The total output of superphosphate from the 20 or so works now in operation, from Sept. 1, 1890, to June 1, 1891, was 278,456 tons, representing a cash value of $4,175,500.

The production of phosphate rock from the South Carolina beds during the present year will probably be less than in any year for a long time, on account of the litigation between the state and the Coosaw Mining Co., one of the largest producers.

The facts connected with the litigation are briefly that the legislature in 1870 gave an exclusive franchise for 21 years for mining phosphate rock in the navigable waters of the state. The above-named company secured the exclusive right to the Coosaw River district, claimed to be the most valuable known bed of phosphate in existence. In 1890 the company mined 107,000 tons of rock, valued at about $750,000, or nearly one fourth the total output. It is claimed that the total cost of production to the company was less than $4.25 per ton (including a royalty of $1.00 per ton paid to the state). This, it will be seen, leaves enormous profits. When the royalty of $1.00 per ton was established in 1876, the mining company claims that the franchise was made perpetual. The State claims, on the other hand, that the franchise expired on March 2, 1891. A State Phosphate Commission was appointed and prepared to lease the Coosaw Company's territory to other parties; an injunction was secured from the United States Courts, however, and mining in this territory is therefore at a standstill for the present.

This reduces the output of river rock nearly one-half, and gives an excellent market to the newly established producers in Florida, on whose work and prospects we shall give an account next week.

PHOSPHATES OF NORTH CAROLINA AND ALABAMA.

Beds of phosphate nodules occur in the south-eastern part of North Carolina, and in 1884 they were thoroughly examined by the state agricultural department. Dr. PENROSE says the result seemed to show that the phosphates were either too scanty in quantity or too poor in quality to be of much commercial value. The nodules average of larger size than those of South Carolina, but analyze only about 45% of phosphate of lime, and occur only in small patches of one to twelve acres. A phosphatic conglomerate is also found in New Hanover and Pender counties, the whole mass containing 10 to 20 % of phosphate of lime. It has been ground and used as a fertilizer with some success.

The phosphate deposits of Alabama belong to the cretaceous formation, and are found in two parallel belts running across the state. In only a few places, however, are the deposits of considerable extent. At Coatopa, Sumter Co., and at Hamburg are deposits which may perhaps become of local value. The deposits are more difficult to mine than those of South Carolina, and cannot be shipped as cheaply.

(To be continued.)

The Position of Electric Tramways in England.

FROM A LONDON CORRESPONDENT.

One of the most difficult problems—in fact, the burning question of the day—which English electrical engineers concerned in the development of electric traction have had to solve, has been to induce the tramway companies in the United Kingdom to become interested in the subject of substituting electric traction for horse or steam haulage, or to adopt the former agency on new tramways. At the present time there are from 950 to 1,000 miles of tramway in the United Kingdom. The greater portion of this mileage is worked by horse cars, only about 30 miles being operated by electricity. All the latter, with the exception of the City & South London Electric Ry., are short experimental lines, worked on the third rail, open-conduit and the storage battery systems, the overhead-trolley system so general in the United States being entirely absent. Most of the 30 miles are operated by private individuals or companies; the Birmingham Central Tramways Co. and the North Metropolitan (London) Tramway Co., which are experimenting with storage-battery cars, being the only two public companies making tests with electric traction. Excepting the short electric tramway at Blackpool, a seaside resort on the Lancashire coast, all other electric lines have not proved to be commercially successful undertakings. It is therefore not surprising that English tramway companies should regard electric-traction schemes with indifference. They do not seem disposed to seriously consider the subject of adopting electricity as a motive power until it can be actually demonstrated that any particular system can be made a financial success, and they do not appear to be prepared to expend money in making experiments on their own account. In fact, the essence of their feeling is, "Does electric traction pay?"

The first occasion that the subject of electric traction was brought prominently under the notice of English tramway companies was a year ago at the annual meeting of the Tramways Institute of Great Britain and Ireland. A more representative body of men could not possibly be found, as the members of the Institute comprise the directors, managers and engineers of the whole of the tramways in the United Kingdom. Papers were read descriptive of the accumulator cars in Birmingham and those in service on the North Metropolitan line at Barking, in the east of London. The papers were not of special interest, but the discussion was of a lively nature. This was due mainly to the fact that one speaker brought forward data tending to show that the storage-battery cars at Barking had proved to be a failure from a commercial point of view. That statement has never been denied by the contractors, who were challenged to disprove it if possible. Taken all round, the meeting was of unusual interest, and it was stated that at the next assembly electric traction on tramways would be seriously considered.

That "next assembly" took place to-day (July 2), under the presidency of Mr. W. J. CARRUTHERS-WAIN, chairman or director of seven English tramways. The meeting was attended by a large number of members and by several well-known electrical engineers, and the proceedings, a short summary of which will be interesting as showing the present feeling of tramway companies and promoters of electric traction, were of an animated character. Papers on the following subjects were read: "Lineff System of Electric Traction," by Mr. GISBERT KAPP; "Self-Contained Electric Tram Cars," by Mr. A. J. JARMAN," and "The Gordon System of Electric Traction," by Mr. J. GORDON. The Lineff system is of the closed-conduit type. The current is collected or "picked up" from a third rail laid in sections either at the side or in the middle of the line, the collection being effected by means of a brush attached to a large magnet carried under the car. The current passes from the generating station along a copper conductor laid on insulating tiles at the bottom of the conduit, and on the top of the conductor lies a strip of hoop iron. When the car is on the line and the current is passing, the iron strip is attracted into contact with the sectional rails, and a second rail immediately under the surface, and the current passes through the latter, is picked up by the brushes and passed through the magnet and motor, thence returning to the generating dynamo by the ordinary track rails. It was found with this arrangement of conductor that the insulation resistance was only 4,475 ohms per mile. Mr. KAPP therefore recommended a different kind of conductor, a sample of which was shown. It consists of a copper trough supported at intervals by earthenware insulators, instead of the conductor touching the bottom of the channel along its whole length, as was the case formerly. By this means the area of the surface along which an escape of current can take place has been greatly diminished and the insulation very much increased. The insulation with this method averages 35,000 ohms, and Mr. KAPP was of opinion that it might be further increased to 100,000 ohms.

The paper on "Self-Contained Electric Tram Cars" gave a description of the Jarman storage battery system. This method is at present being promoted by the Electric Tram Car Syndicate, and two cars are now ready for experimental work on one section of the London Tramway Company's system. The accumulators are arranged under the seats of the car, and by a special arrangement the exhausted cells can be quickly withdrawn endwise from the car, and freshly charged cells substituted. The motor, which is carried on a steel frame under the car, consists of two bipolar field magnets joined by one yoke, the weight being therefore more evenly distributed over the supports. There are two armatures attached to one single shaft, each armature revolving within its own field. The field magnets are wound in series, with an additional winding of smaller copper wire which acts as a resistance, no external resistance being employed. Thus, on starting the motor, the two field magnets with both armatures are brought into action with the wound-in resistance all in series, the result being, according to Mr. JARMAN, that the car starts from a point of rest with far less current than it is possible for any single-armature motor to do. The next movement is to cut out the resistance of each field and work the compound motor in series; the third speed is obtained by cutting out one motor altogether, leaving the other to perform the work alone; the next speed is secured by connecting the compound motor in parallel. A test with this motor gave the following results: (1) A current of 30 ampères as made to pass through one armature and one field magnet, and this gave a torque of 60 lbs; (2) a current of 50 ampères was put through and gave a torque of 97 lbs; (3) the motor was then coupled with the two windings in series through both field magnets and both armatures, and a current of 28 ampères passed through gave a torque of 117 lbs. Thus by coupling the motor in this method, and by using no external resistance, nearly double the torque or starting force is obtained, with only half the current to do it. A run with a fully loaded car of 44 passengers was accomplished on a gradient of from 1 in 18 to 1 in 22 with a current used of 50 ampères at 50 volts. The speed of the armature shaft is 650 revolutions at eight miles an hour, the power of the motor being 14 HP. The gearing consists of wrought-iron pinions and mortice wheels; the switches, one of which is arranged at each end of the car, are cylindrical and are so made that either a forward or backward motion of the motor is attained without the use of reversing gear or levers. Until quite recently Mr. JARMAN has used E. P. S. cells, which, and also other storage batteries, are considered to have reached their maximum efficiency, which, to say the least, is low. Mr. JARMAN is, however, not of this opinion, as he has devised a storage battery which he claims will bear at least half as many again discharges as those now in use before any renewal of the positive plates is necessary. The serious objection of the burning asunder of the leaden lugs and bridges, due partly to the flow of a heavy current, but mostly to the cracking and crystallizing of the lugs and bridges, has been overcome by inserting a solid quarter inch tinned copper conductor in the center of the lug and bridge and duplicating the connections throughout. This makes a combined lug and bridge which will carry 450 ampères safely, and at the same time the internal resistance of the cell is reduced to one-half, the tendency being, when the flynuts are tightened, to improve the connection rather than to injure it. The flynuts of these cells are made of aluminium and weigh only 100 grains when finished. The plates of the cells are an alloy of aluminium and lead. This alloying stiffens the plate and increases the capacity of the negative plate to absorb and retain hydrogen. The form and construction of the plates are such that the material which eventually becomes active is so keyed in that it cannot and does not fall out when the battery is in action, and Mr. JARMAN has not found these plates to buckle even when discharging up to 300 amperes. He estimates that the consumption of fuel, wear and tear of machinery and renewal of batteries would cost 2d. (4 cents) per car mile run in a large installation—probably 20 cars.

The paper on the "Gordon System of Electric Traction" referred to a method of closed conduits. The general principle of the system is a series of contacts, charged by means of automatic magnets in a box placed in the ground every 100 yds. or about 16 to the mile of line. The current is picked up from the third rail, laid in sections by means of a magnet carried on the car. Any kind of gear or motor car can be used. The system is being experimented with in London.

It will be unnecessary to refer at any length to the discussion, which, although taken separately on each paper, pointed to the same result. The discussion was participated in by the representatives of the principal tramway companies, and by Messrs. G. KAPP, A. LINEFF, A. RECKENZAUN, HOLROYD SMITH, A. DICKENSON, etc. As far as electrical engineers were concerned, they were naturally in favor of the adoption of electric traction, but opinion was of course divided as to the best system to employ. On the part of the tramway companies, estimates were asked for and obtained regarding the first cost of installation, cost of maintenance and cost of working

per car mile. The data given, although consisting only of estimates, seemed to greatly interest the tramway directors, who appeared inclined to adopt either an underground or storage-battery system, provided one or the other could be worked more economically than either steam or horse haulage. Several tramway companies offered to allow experiments to be conducted on sections of their lines, and the general conclusion to be drawn is that English tramway companies are ready to substitute electric traction for present methods if the results are commercially successful. The ultimate result of the meeting will doubtless be a great extension in electric traction in this country.

Standard 85-lb. Rail and Joint; Baltimore & Ohio R. R., 1891.

The Baltimore & Ohio R. R. has approved and adopted, under date of May, 1891, a new form of standard rail section and joint, which are shown in the accompanying cuts, prepared from blue prints furnished by Mr. H. T. DOUGLAS, M. Am. Soc. C. E., Chief Engineer. This track is to be laid on the division between Baltimore, Md., and Philadelphia, Pa., which is now laid with rails weighing 67 lbs. per yd.

The rail weighs 85 lbs. per yd. and the joints are spliced by 30-in. angle bars and six bolts. The rail

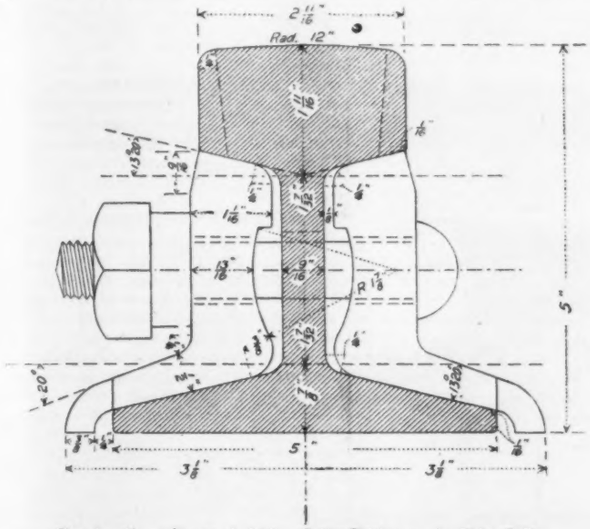


Fig. 1. New Standard 85-lb. Rail; Baltimore & Ohio R.R.

middle bolts are spaced 4 ins. c. to c., the next 5 ins. and the outer ones 6 ins., the latter being 2 ins. from the end of the bar. The flanges are notched for spikes. The bolt holes in the rail are circular, while those in the splice bars are oval, ⅞ × 1⅛ ins. The bolts are shown in Fig. 3. They are 4¾ ins. long over all, ¾-in. diameter, with cup heads and oval necks ¾ × 1⅛ ins. The nuts are 1¼ ins. square and ⅝-in. thick. Spring washers or nut locks are used. The ties are of white oak, spaced 8 ins. apart, 20 ins. c. to c. of joint ties. The rails will be fastened to the ties by standard railway spikes. The ballast will be of broken limestone where that material can be obtained, and in other places furnace slag, gravel and hard sandstone will be used.

In our issue of April 4, 1891, we described and illustrated the 95 lb. rail joint and tie plates adopted for the standard track of the Boston & Albany R. R., and also referred to other instances of the use of heavy rails in this country. We may add that the Great Northern Ry. Co. intends to lay 85 lb. rails on the heavy grades of the Pacific extension of the St. Paul, Minneapolis & Manitoba Ry.

Electric Lamps without Wires.

The investigations into the properties of alternating electric currents of high frequency made a few years ago by Prof. HERTZ, and the brilliant speculative and experimental work of Dr. LODGE in the same field, have been carried on in this country by Mr. NIKOLA TESLA. Several months ago he read a paper before the American Institute of Electrical Engineers, and repeated his chief experiments. This paper attracted universal notice among electricians, and its publication last week marks one of the greatest achievements of American electricians. It is especially interesting at this time owing to the possibility there outlined of producing light without wires to the lamps. Mr. TESLA is connected, we believe, with the Westinghouse interests, and if this new method of lighting proves practicable and cheap the recent decision of Judge WALLACE in favor of the Edison incandescent lamp patents against the claims of the United States Electric Lighting Co., a Westinghouse company, may not prove so important after all.

The experiments in question were made with alternating dynamos of very high frequency and with induction coils of special construction. With the apparatus employed, the ordinary induction-coil experiments could be repeated with greatly enhanced effects; but the greatest interest centers about the experiments with new forms of lamps.

In one form shown, the glass bulb became practically the insulator of a Leyden jar. Inside the bulb or jar was a filament of carbon or a button of some highly refractory material on a wire. This wire was connected with one end of the secondary coil of an induction coil, the other end of which was grounded in various ways. This button or filament could be made to glow as well as a lamp of the common type with two leading wires. Numerous methods of increasing its brilliancy have been discovered, such as enormously increasing the frequency of the alternations of the current by employing condensers, which are discharged disruptively.

While experimenting with these lamps, Mr. TESLA was led to study the behavior of glass tubes, exhausted of air, in the presence of plates connected with the terminals of an induction coil, and he found that such tubes would give out considerable light when between or near these plates. If this method of producing light can be made practicable it will be a great advance over our present practice, since the lamps may then be carried from place to place without hindrance from wires. The walls of the rooms would then be connected with an induction coil, which in turn would be supplied from an alternating dynamo in a central station.

The Disposal of Refuse in American Cities.

While the report of Mr. WALTER V. HAYT, General Sanitary Officer to the Chicago Department of Health, lately issued, is an odd document in its phraseology, there is a considerable quantity of valuable matter contained therein on the important subject of disposing of the waste products of great cities.

From the reports of the ten largest cities in the United States Mr. HAYT briefly summarizes the several methods of disposal of garbage and refuse, with the following results: In New York it is collected by city teams, loaded on boats and dumped into the sea. Philadelphia removes its garbage by the aid of small contractors who sell much of it to truck-farmers; and the system is very unsatisfactory and a failure from a sanitary point of view. Brooklyn follows the methods of New York. St. Louis collects the refuse and discharges it at certain dumps. The method is admitted to be antiquated and unsatisfactory in the highest degree, and cremation is recommended. Boston disposes of 350,000 loads of garbage, ashes, street-sweepings, etc., annually, at a cost of about $500,000. That city recommends the arrangement of the kitchen stove in such a manner as to enable each family to burn up much of its refuse as it is made. Baltimore says that "the offal and filth of cities must be deposited somewhere, and is from the nature of things a nuisance to those who reside in the neighborhood of the dumps." It says further that its present system, while far from perfect, is the best its circumstances will allow. San Francisco recommends garbage furnaces as a substitute for present inefficient methods.

Cincinnati contracted for 10 years, dating from Jan. 31, 1883, with a private company to remove, for the sum of $2,500 annually, all "vegetable garb-

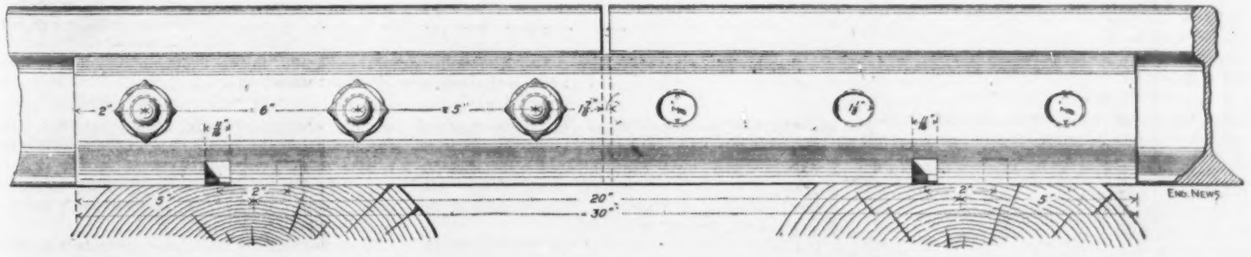


FIG. 2. SIDE ELEVATION OF JOINT FOR 85-LB. RAIL; BALTIMORE & OHIO R.R.

has vertical sides to the head and web, and its dimensions are as follows:

	Inches.
Total height	5
Width of base	5
Width of head	2⅛
Depth of head	1⅛
Height of web	2⅞
Depth of flange	¾
Thickness of web	⅝
Height from base to center of hole	2⅜
Radius of top of head	8
" top corners of head	¼
" bottom corners of head	⅛
" top fillets	¼
" bottom fillets	¼
" top and bottom corners of base	¼
Fishing angles of head and base	13° 20′

The joints are suspended, and are spliced by angle bars 30 ins. long, with six bolts. They are shown in section in Fig. 1, and in elevation in Fig. 2. The angle splice bars weigh 23.88 lbs. each. The two

age, dead animals and slaughter-house offal within the limits of the city. This company must remove all animal matter from dwellings and hotels at least three times per week and all slaughter-house offal daily. Ashes and other refuse matter must not be mixed with vegetable garbage. The bargain is said to be better for Cincinnati than for the contracting party. Cleveland says candidly that the private collecting methods are entirely inadequate, and the health officer recommends "a systematic gathering" of all refuse.

In Chicago the total cost of the scavenger service for the year 1889 was $253,140.72. The area covered aggregated 174 sq. miles, including in this 2,047 miles of streets and about 3,000 miles of alleys. It is admitted that this service is only "fair." In one ward only is there a daily service;

outside of this it was tri-weekly. About 225 teams have been regularly employed by the contractor to whom this collecting is let, and by the city, and an average of 2,000 cu. yds. per day is removed and deposited in clay holes, removed by train beyond the city limits, or from Feb. 19 to Oct. 15, 1890, burned by the Chicago Garbage Reduction Co. This company burned 7,208 tons of garbage in this period. For the year 1890 a total of 325 teams was demanded, and Mr. HAYT recommends radical improvements in the contract system of collecting, "if that is to be continued." These recommendations cover the employment of a minimum number of teams, a wagon box of standard size, with a proper canvas cover, wagons to be plainly marked with ward and number.

The cremation of garbage and other refuse of a perishable nature is strongly recommended and the separation of ashes from garbage insisted upon, under penalty of leaving the garbage to be removed by the sanitary inspectors at the cost of the householder.

The nuisance created by horse manure is particularly pointed out. The Brooklyn report remarks that about 25,000 horses produce daily about 200 tons, including in this the particles of straw. This was removed promptly by farmers in the early spring; but as summer advanced and it was not needed for the crops, it was allowed to accumulate. The experiment was then tried of baling it, like hay and straw. It was found that this was possible when the manure was taken fresh, and that by using the bale-stick and the wires from the hay and straw used in the stables the cost and time did not exceed that in carting it to the manure pile. The cost of stick and wire new was 4½ cts. per bale. The advantages gained were: Reduction of bulk, the prevention of fermentation, thus enhancing its value as a fertilizer, and finally it could be shipped without causing offense.

In Chicago it is estimated that the 100,000 horses of that city produce an average of 750 tons of manure daily; and this does not include the product from the Stock Yards. The health officer commends the baling plan of disposal. In the year reported upon 24,419 dead animals were removed from the city, not including those from the Stock Yards. Cremation is recommended for getting rid of this mass of usually foul matter, and natural gas is suggested as the possible fuel. In the year a conservative estimate of the night-soil removed puts this volume at 21,843 cu. yds. While the old-fashioned vault is fast passing away, they still exist in sufficient number in the older part of the city to demand more stringent regulations for the removal of their contents. This work is now performed by private contractors; and after the permit is issued the Health Department loses all track of the contracting party, with the result that leaking carts are used, and the contents are now and then surreptitiously dumped in outlying streets and alleys. Mr. HAYT very properly protests against this and advises the use of proper carts, a system of permits which will fix responsibility, etc.

Obtaining a Filtered Water Supply from Rivers.

The subject of obtaining a supply of potable water for towns situated on rivers with sandy beds and without other available source of supply, is discussed in a late issue of *Le Genie Civil*. The City of Nantes was in this manner confined to the River Loire for water, and Mr. LEFORT, Engineer in Chief for the Department of the Lower Loire, made a study of the situation with the following results:

Natural filtration was possible by two different methods: filtering wells and filtering galleries with storage reservoirs in dry stone and in natural sandy masses, running parallel with the course of the river, or an artificial island placed in the stream and provided with special filtering appliances. As far as the filtering wells or galleries were concerned, the experiments of BELGRAND, in studying the feasibility of leading the water of the Loire to Paris, after it had been filtered, showed that these galleries and wells along the river bank not only obtained their supply from the river, but also tapped, in part at least, the subterranean flow from the neighboring shore. He proved this by two experiments. He first observed between the water in the river and that in the filter reservoirs a certain hydrometric difference or a difference in densities sometimes amounting to as much as 15° C. Then he noticed that as the water fell in the river there was an increase in the organic matter in the filter-reservoir.

Mr. LEFORT argues that by the inherent situation of rivers occupying the lowest portion of their valleys, they must receive the water flowing from the adjoining banks, and receive this water either laterally by reason of the difference in level between the water surfaces, or from their bottom by virtue of piezometric force. Consequently all filters, whether placed in the middle of the stream on an island or upon the bank, are subjected to inflow of other water than that which comes from the river proper. By river water proper he here means the water of the upper strata of the river that has been sufficiently exposed to the influence of oxygen to at least reduce in volume any organic matter contained in the water. He considers that the water in any river is arranged in two superimposed layers; the upper stratum proceeding from points more elevated than the river itself, the lower coming from subterranean sources and liable to pollution.

He also says that it is a well-recognized law in hydraulics that in any mass of filtering sand, natural or artificial, there will be produced at the end of a certain time waterways, true "fistular passages," or small channels often of considerable area, and in any case sufficient to feed the filtering reservoir. From which Mr. LEFORT concludes that in a natural filter the water, if it does not come from contaminated subterranean sources, is simply river water, strained but not filtered, thanks to the want of homogeneity in the filtering mass, natural or artificial.

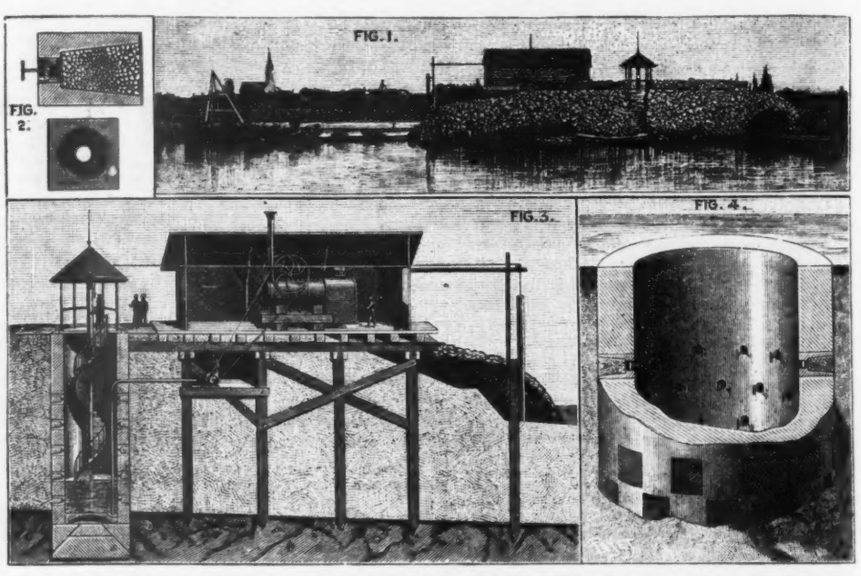
The work of Mr. DUCLAUX, of the Pasteur Institute, and Messrs. FRANCKE and PIEFKE, of the Institute of Hygiene, of Berlin, shows that when the active bed of a filtering basin exceeds 2 millimeters in thickness (0.078 in.), the pressure on the sand filter should not exceed 25 centimeters, or 9.8 ins.; otherwise oxidating action of the air will not be sufficient for the filter. These conditions are certainly not realized either in horizontal filtering basins or in wells and artificial filtering galleries. Finally, in all these systems, the pressure being vertical, either from the bottom or from the top, as shown by the experiments of DUPUIT, the filtering bed will inevitably be clogged and fouled in time.

For the reasons here given Mr. LEFORT proposed a filtering system in which the following conditions should be considered:

Stopping off from the filtering reservoir of all neighboring subterranean streams; stopping off the lower stratum of the river water; the absolute homogeneity of the mass of filtering sand; the oxidation possible of the working surface of the filter; the certain and constant regulation of the air pressure. Finally, a lateral pressure to effect the filtering sources and to reduce the clogging.

To accomplish these results he proposes the following apparatus: After dredging the bed to a firm foundation he would place out in the stream of a river a circle of rock, about 50 ft. in diameter, as a protecting circle to the base of the filtering system. In the center of this he would build a "well tower," sealed absolutely from its base to a level slightly above the high-water mark in the river. From about 1 meter below the minimum stage of water are openings called *barbacanes*. These are made in cement, of a truncated cone-shape, fitted at the inner end with a valve, and at the outer end with a metallic screen. This caisson is then filled with gravel stones of varying dimensions, and so disposed that the size decreases as the inner end of the cone is reached. A spiral stairway inside the well permits the manipulation of these *barbacanes* and the cleaning of the system.

Then between the central tower and the ring of rock would be deposited fine river sand, uniform and well washed. This sand cone would have, in this special case, a diameter of 50 ft. at the bottom and a height of 33 ft., and would be enveloped with a shell of loose stone, so arranged as to insure the stability of the sandy mass without interfering with its porosity or aëration. At the bottom of the well a pipe terminates, which is connected with an "aspirator and forcing pump," which sends the purified water to a cistern connected with the general distribution system.



THE LEFORT SYSTEM OF WATER FILTRATION.

Fig. 1. Trial Plant at Nantes. Fig. 2. The Barbacanes. Fig. 3. Vertical Section of Filtering Well. Fig. 4. General Arrangement of the Barbacanes.

In attempting to put this system to a practical test, Mr. LEFORT had but $7,000 available, and as a consequence his plant was experimental only. He utilized one of the many natural sandbanks in the river in front of Nantes, instead of building up the whole system as here described. He selected a large bank about one mile from the center of population. He there built his tower, and stirred up the mass of sand so as to assure as perfect homogeneity as possible, and finally covered the sand with loose rock.

A pump was set upon the artificial island so formed, but the water pumped out was simply thrown back in the river for about 65 days, lifting from the well in this time about 26,418,000 galls. of water. For 14 months this well was operated during varying stages of the river, and the general results of this filtering system can be given as follows:

During a whole year the water showed no color in thin layers, and was blue in deeper strata; it was absolutely limpid, transparent, of an agreeable taste

with no odor. The physical properties, as compared with the waters of the Loire, were:

	Temperature—Centigrade.		
	of the air.	of the Loire water.	of the water in the well.
Winter	+ 1°	+ 0°.30	+ 8°
	+ 5°	+ 3°.0	+ 7°
Summer	+ 21°	+ 21°	+ 17°
	+ 21°	+ 20°	+ 17°

In comparing the chemical characteristics of the river water with the filtered water, the following results were obtained:

	Loire water.	Filtered water.
Hydrometric value	10°.0	10°.5
Residue from filtration, per liter	.012 grammes.	.000 grammes.
Residue from evaporation, per liter	.152 "	.140 "
Organic matter tested by permanganate of potash:		
(1) Equivalent per liter in oxalic acid	.0279 "	.0088 "
(2) Quantity of oxygen necessary for combustion	.00346 "	.0011 "

From these analyses it is concluded that the composition of the two waters is identical, chemically, in its mineral matter, and consequently the water filtered comes exclusively from the upper stratum of the river water; there is also a complete retention of the mineral and organic matter in suspension, but the decrease in the elements in solution has been considerable. The aëration of the water furnished by this well approaches closely that of the average rain water, as shown by the experiments of PELIGOT. They compare as follows:

	Lefort well.	*Rain water.*
Azote	.01720 gramme.	.01900 gramme.
Oxygen	.00630 "	.00710 "
Carbonic acid	.00450 "	.00240 "
Total per liter	.02750 gramme.	.02850 gramme.

The decrease in bacteria per cu. centimeter for the extreme stages of the river is indicated in the following:

	Lefort well.	*Loire water.*
High water, winter	73 per c. c.	9,530 per c. c.
Low water, summer	132 "	24,000 "

The general result of the experiment was deemed highly satisfactory by the authorities of Nantes, and the question of cost for a city plant was answered by Mr. LEFORT as follows: For a filtering plant capable of yielding about 660,000 galls. of clean water in 24 hours, and taking into consideration the dredging of the foundation and lateral channels to the filtering island, with wells complete, the cost would be $12,500. For 12 wells, supplying 120,000 inhabitants 45 galls. per head per day, the total cost would be about $150,000.

In this connection some interesting matter is given comparing the water obtained by this system with the waters now supplied to Paris. From a chemical point of view it is shown that the water of the Vanne, deemed the purest supply entering Paris, has an average hydrometric value of 20°.5, as compared with 10°.5 for the Lefort well and 10° for the water of the Loire. From a bacteriological point of view the water supplied to Paris to-day shows the following annual averages per cu. cm.:

	Bacteria.
Water of the Vanne	705 per c. c.
" " Dhuis	1 890 "
" " L'Ourcq	36,190 "
" " Marne	28,510 "
" " Saint Maur	2,110 "
" " Seine at Ivry	27,340 "
" " " Austerlitz	31,060 "
" " " Chazillot	77,525 "
Water filtered by the Lefort well	100 "

Legal Decisions of Interest to Engineers.

Right to Reject Lowest Bid.—Where the statute governing the letting of contracts for public works provides that such contract shall be let to the lowest responsible bidder, and the advertisement for bids reserves the right to accept or reject all bids as the best interests of the city may demand, all the bids may be rejected and another advertisement made, without in any manner incurring any liability to the lowest responsible bidder under the first advertisement. (American Artificial Stone Pavement Co. v. Wagner, Sup. Crt. of Pa., 21 At. Rep. 160.)

Lobbying Contract Contrary to Public Policy.—A person rendered service in "soliciting, advocating and procuring" the franchise for a municipal corporation to light its streets by electricity. The particular services performed were the canvassing of the city, getting acquainted with its aldermen, explaining to them the advantage of lighting by a certain system, and asking them to advocate it if they thought it was for the best interests of the city. But it has long been settled that a contract to induce a public officer or member of a legislative body to do any official act is illegal and void. (Wilbur v. New York Electric Construction Co., Sup. Crt. of New York City, 12 N. Y. Supp. 456.)

The Grand Avenue Bridge, St. Louis, Mo.

(WITH INSET.)

In connection with our inset of June 27, showing a general front view of this bridge, we now give a more detailed insect well illustrating some of the more novel features in this handsome structure.

As here shown, the three-hinged inverted arch has its stiffening system placed beneath, and with its chords parallel to, the suspension members. The gain in symmetry and general effect is very marked as compared with other systems of combining the stiffening truss and what may be called the cable of the suspension bridge.

The floor system cuts explain themselves, but the anchorage is so arranged that it is accessible throughout, and will permit free expansion of the members inside of the anchorage pier. The illustrations clearly show how this is done without further description.

It may be repeated that mild steel was used for the main trusses and towers, and wrought-iron for the floor system and wind trusses. The bridge was built by the King Iron Bridge Co., of Cleveland, O., from the design of Mr. CARL GAYLER, Bridge Engineer for the City of St. Louis, Mo.

An Old Japanese Standard Foot Measure.*

On the fourth of April, 1873, at the Treasury Department of the Japanese government, an old standard measure of length, called the Tsuchimikadoshaku, also more vulgarly called the Tesshaku, or iron foot, was shown to me. It was a bar of iron about half an inch or five-eighths thick, and 16 ins. long and 2¼ ins. wide, but hollowed out into the shape of a narrow link, widened a little for about 3 ins. at one end and five-eighths of an inch at the other end, as shown by the accompanying drawing roughly copied from it. The bar contains three standards of length, measured between certain interior angles of the link.

Fig. 1. The Tsuchimikado Shaku. An Iron Standard Foot Measure Brought from China to Japan, A. D. 1047, and Apparently Legalized by Tsuchimikado (1188–1234). Scale about $\frac{3}{16}$.

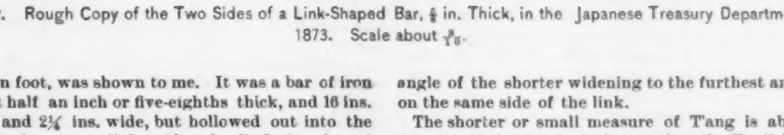


Fig. 2. Rough Copy of the Two Sides of a Link-Shaped Bar, ¼ in. Thick, in the Japanese Treasury Department, 1873. Scale about $\frac{3}{16}$.

It is another of the numerous cases where an opposite method is adopted in the extreme East to what a European or American would consider the most natural one—instead of using a simple bar as a standard, the space inside the hollow of a link is taken. Although we are apt thoughtlessly to condemn the ways of others as ridiculous and less practical or advantageous than our own, it often happens that the Oriental method, if the choice be not wholly a matter of indifference or of chance, is in reality more rational and better suited to the circumstances of Eastern countries. In the present instance, the method chosen is not without some arguments in its favor. A simple bar as a standard of length is subject to change from the wearing off of its ends, especially at the corners, either in use or in the rubbing to which it may be exposed in the course of centuries, even if it be, with additional complication, ordinarily preserved in an outer protecting case. On the other hand, a standard length taken between the inner angles of a link can, with moderate care, never become shortened in time and is little liable to any alteration either from legitimate use or from accidental wear. The iron link is itself a strong and inseparable protector around the standard. The weight of the argument for invariableness, security, simplicity and practicalness seems then, after all, to be on the side of the Orientals in this case.

As shown by an inscription on the bar or link, it dates back to the year 1047 of our era. The inscription says: "Human king, seventieth reign, Tegai, Eishoo second year first month —— day." Tegai is the name of the year according to the sixty-year cycle, and Eishoo, meaning endless reign, is the name of the first period in the reign of the Japanese ruler Goreizei. The bar is said to have been brought at that time from China to serve as a standard of measures; but as it goes by the name of Tsuchimikado, the Japanese ruler from A. D. 1199 to 1231, it was probably not legalized or enforced as a standard until 150 years after it had arrived in Japan. Or possibly Tsuchimikado, the name of a noble family, may have been the name of the embassador who brought the bar from China.

It is said that the length on the face that bears the inscription from the inner angle of the link at the longer widening, but at the corner furthest from the inscription, to the nearest corner of the shorter widening, is the standard for the "great measure of T'ang," the country and dynasty that ruled in China from A. D. 620 to 907. The standard for the "small measure of T'ang" is upon the other face of the bar, and is the distance from one extreme angle of the shorter widening of the link to the nearest corner of the larger widening. The "whale foot," as it is called in Japan, is the full length of the link on the same face of the bar from the other extreme inner angle of the shorter widening to the furthest angle on the same side of the link.

The shorter or small measure of T'ang is about one-sixteenth of an inch shorter than the English or American foot, and is the same as the ordinary foot of Japan at the present day, except that for the past 165 years the length of the common foot measure has been regulated by another standard called the Kiyoohooshaku, which, according to a brass copy of it in the Japanese Treasury Department, is, it is said, about a thousandth of a foot shorter than the Tsuchimikado standard. The Kiyoohooshaku is said to be probably like the present bar in form and material, and was established as a standard by the Shoogun Yoshimune (1716–1745) from some measure in the Kumano temple at Honguu (or possibly Shinguu) village in the province Kii, some 60 miles south of Osaka. Kiyoohoo is the name of the period A. D. 1716–1735. Still another standard of the common foot measure, called the Matashiro standard, is kept at the Osaka mint; but according to a brass copy of it in the Treasury Department, is, it is said, four-thousandths of a foot shorter than the Kiyoohooshaku. Within the last few years the mean of these two standards has been adopted for the foot. The common foot of Japan is called kanejaku, or the foot of the carpenters square, which is called magarikane (bent metal), or more shortly kane (metal).

The "great measure of T'ang" is one-fifth longer than the small one, or the common foot, kanejaku; and appears to have been used for measuring land, and is also the Japanese gofukujaku for cloth measuring, but is no longer used in Japan. The whale foot, or kujirajaku, is one-quarter longer than the common foot, or kanejaku, and is now used in Japan

* By BENJAMIN SMITH LYMAN, in Proceedings of the Numismatic and Antiquarian Society of Philadelphia.

for measuring cloth. The name is said to be given because the measure is often made of bone from a whale's fin, and not, therefore, because of the extreme size of the measure.

The measures of T'ang appear to have been introduced into Japan in consequence of intercourse between the countries that became frequent about the beginning of our seventh century, and to have been established by law about A. D. 713, just at the beginning of the strictly historical period, displacing a Corean foot that is said to have long been in use and to have been about one-fifth longer than the kanejaku; and before that spans and Land-breadths are said to have been used. (See Gakugei Shirin, Vol. IV., p. 220.) In A. D. 713, 717 and 720 laws are by the same authority said to have been made in regard to weights and measures, based on those of T'ang, and standard measures and weights to have been distributed to the provinces. It is clear that even in those days the Japanese, with their remarkable appreciation and docility, were ready and eager to adopt from the most enlightened foreign countries the results of the best civilization known to them.

Indeed, it may well be questioned whether better enlightenment could have been found anywhere in the world at that time than in China. In the matter of standard measures—and perhaps there is no better single test of the enlightenment of a country than the precision and uniformity of its measures and weights—the foot measure of the T'ang dynasty, and presumably the one already long used in the country T'ang, was far from new, and is in fact claimed to be the same as the one established by the Shang dynasty, some 3,000 or 3,500 years ago (B. C. 1766-1122). The Shang foot is said (Wakansansaidzue, Vol. XXIV., p. 2) to be just one-fourth longer than the foot of the previous Hia dynasty, the first thoroughly historical dynasty, about 4,000 years ago (B. C. 2205-1766); and from that time to the present the Chinese foot has always been divided into tenths and hundreds, a decimal division of measures that does not even now date back a hundred years in any part of Europe, though our decimal arithmetical notation has been a special European, but not Chinese, argument in its favor for nearly a thousand years. In the more or less fabulous period before the Hia dynasty the foot is said to have had the same length as the Hia foot, but to have been divided into ninths and eighty firsts, as far back as Hwangti, 4,500 years ago (B. C. 2697-2597). It is claimed that by his command his musician Ling Lun made the first standard of length from a joint of bamboo that when used as a pitch pipe gave forth a certain note. The contents of the pipe also served as the base of measures of capacity, and so too of weights. The idea of taking a pitch pipe as a standard of measure may seem fanciful and more poetical than practical, but certainly compares favorably with the origin of our own standard measures, the length of the king's arm about 800 years ago. It bears some resemblance, moreover, to the very modern project of taking for a standard the length of a wave of light of a certain color.

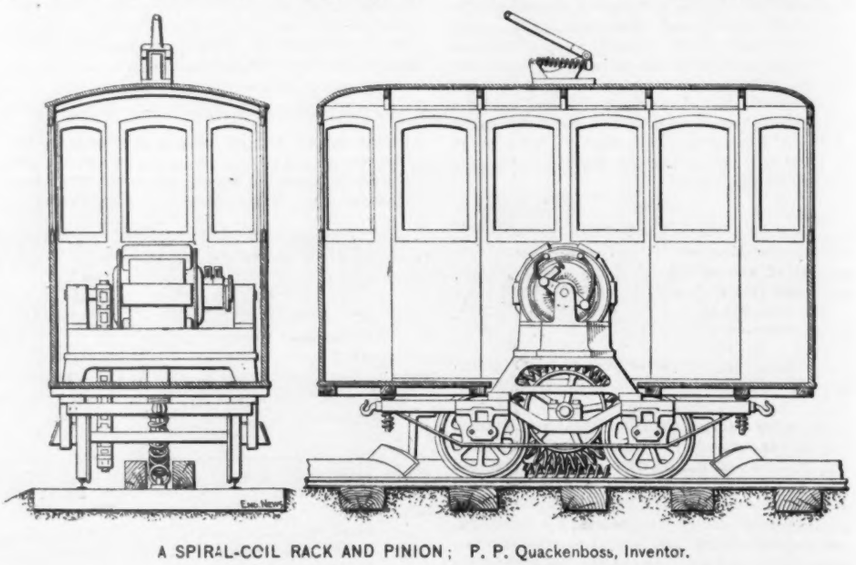
A Novel Rack-and-Pinion.

While the rack-and-pinion, as applied to tramway traffic, was one of the earliest forms proposed, it was almost at once abandoned on account of its great first cost, its rapid wear and the fearful noise accompanying its operation. It is now applied to exceedingly steep gradients on the ABT principle, and does good work; but the cost of the gear required limits its application to a few exceptional roads.

That a practical motor on this principle could be made of cheaper form, and without cut gearing, would have seemed doubtful a short time ago. But the cut here given shows a gear that is not cut, that is certainly novel, and that would seem to possess advantages that are peculiarly its own. It is the invention of Mr. P. P. QUACKENBOSS, of Philadelphia, and shows a wheel with a spiral tire traveling on a spiral working track, set between two ordinary 56 lb. rails on which the motor car travels.

The spiral in each case is a rod of tempered steel, 1 in. diameter, wound by specially designed machinery on a mandril 6 ins. in diameter. This tire is made into a wheel 30 ins. in diameter by passing a metal bar of a certain shape through the center of the coil before this coil is made to assume its circular form. With this center bar two steel disks are connected by having their periphery cut into notches by a milling process in such manner that they can be securely fastened to the bar. By adding a hub a strong and light pinion is thus secured.

The power track is formed by straight sections of the same spiral, bolted down to the cross-ties or to suitable chairs, and protected by wooden guard-rails on each side. The latest slow multipolar motor is most suitable for driving the pinion through the medium of a link-belt of proper dimensions. The cut represents it as in use for towing a canal-boat from a track located on the berme bank. The inventor claims that one 3½-ft. track is sufficient, as suitable turnouts can be provided at intervals, and a special "bridge" carried on each moter would enable the approaching motor to pass over the line without injury. The electric current would be taken from an overhead wire with the ordinary trolley. A speed of 6 to 8 miles per hour is promised. Besides a motor for canal-boats, this device will apply to coal mines, for hauling out the product, to steep gradients of pleasure roads and to elevator service.



A SPIRAL-COIL RACK AND PINION; P. P. Quackenboss, Inventor.

A model before us shows that the meshing of the gear is perfect, and it should be almost noiseless in action, as instead of the quick, sharp blow of an ordinary machine-made gear these spirals travel one over the other with an easy sliding motion. It also has the great advantage of being elastic, and thus is capable of yielding somewhat under a suddenly applied load. And lastly machinery is already being constructed that will turn out the spiral of the size and material here used, cheaply and quickly.

EDISON ELECTRIC DRILLS are to be used on the rock-work of 50 miles of the Pend d'Orile division of the Great Northern Ry. for which the San Francisco Bridge Co. has the contract. The right of way lies along the bank of the Pend d'Orile river, and the dynamos will be placed on barges and wires run to the drills. The barges will be floated down the river as the work progresses.

THE NEW UNION PASSENGER STATION at St. Louis, Mo., will be built according to the designs submitted by THEODORE C. LINK, a prominent architect of that city. It is to be erected on Market St., between Eighteenth and Twentieth Sts., and will be of gray granite for the first and second stories and of light colored brick, with stone trimmings for the upper stories. The roof covering will be vitrified Spanish tiles. The train shed will be 600 ft. × 1,000 ft. and will provide for 30 trains standing side by side. The first floor will be below the level of the street and will contain the general concourse, ticket offices, barber shop, baths and toilet rooms, telegraph operators' room, information bureau, etc., and the second floor will contain the waiting rooms, dining room, check room news stands and smoking room. The building will be lighted by electricity and provided with fans for ventilation. The main entrance will be on Market St., and there will also been trances to the baggage rooms and tracks on both Eighteenth and Twentieth Sts. The Terminal R. R. Association has been organized by the various railway companies intrusted to build the structure, and it is stated that proposals for its construction will be invited soon.

A NEW ROUTE from New York to Boston is to be opened by the Long Island Railroad Company in connection with the Housatonic and New York & New England Railways. A ferry to be run from Oyster Bay, on the northern shore of Long Island, about 33 miles east of Brooklyn, to Wilson's Point, on the Connecticut shore, about 10 miles distant, where connection will be made with the Housatonic R. R. It is claimed that Brooklyn and Long Island passengers to Boston will prefer this route, but it is difficult to believe this unless it is made attractive by a lower rate of fare, which in fact will probably be one. A new passenger and freight depot and wharves will be erected at Oyster Bay, and condemnation proceedings have already begun.

WORK ON THE HENNEPIN CANAL, toward the construction of which the last Congress appropriated $500,000, will soon begin. It will run from Hennepin, Ill., on the Illinois River, to the mouth of the Rock River below Rock Island, Ill., a distance of 90 miles. It is to be 80 ft. wide and 13 ft. deep, and will pass vessels of 230 tons burden. The surveys have been completed and 12 miles of the right of way secured. The object of the canal is to open navigation from the Northern Illinois River to the Mississippi River and save the long trip down the Illinois River to the Mississippi.

THE GEODETIC SURVEY OF THE CALIFORNIA AND OREGON COASTS which was begun in 1871 has been completed. The survey has been carried on in the Government steamer *Hassler*, which was built especially for the purpose, and its results have been published in the charts of the United States Coast Survey from time to time. The most interesting fact developed in the survey is that the coast line of Southern California is more abrupt than that of any part of the Atlantic or other position of the Pacific. At a point just above Monterey the hundred fathom point was reached within a mile of the shore, while in the Atlantic and South Pacific it is from 25 to 100 miles from the shore.

THE HATTERAS CAISSON was reported as wrecked on July 8, on the Diamond Shoal. This report is practically denied by officers of the Lighthouse Board in Washington, who up to July 10 had received no information of any disaster. It is reported that Messrs. Anderson & Barr, the contractors

for erecting this lighthouse, grounded the caisson successfully on July 1, and thus had about 7 days to secure it before the date of the reported wreck. Mr. ANDERSON believed that 24 hours of good weather, after reaching the site, would be sufficient to secure the caisson against serious damage by a storm.

As we go to press we receive the following significant item from the office of Messrs. Anderson & Barr; it tells its own story:—LOST. On Diamond Shore, off Cape Hatteras, July 8, during a severe storm, one caisson. A liberal reward will be paid to any one finding and returning the same in *good order* to the undersigned.

PROPOSALS FOR BUILDING GREAT GUNS were opened at Washington, D. C., on July 13. The bids covered 25 8 in., 50 10-in. and 25 12-in. breech-loading, rifled, built-up steel guns. The appropriation for these guns was $4,225,000. The bids were as follows: Midvale Steel Co., one 8-in. type gun, with ammunition for testing, $22,028, to be delivered in 3 years; 25 service guns of the same pattern at the same price each, to be delivered in 8 years after acceptance of the type gun; one 10-in. type gun, $51,880, and 44 service guns at the same price each, to be delivered in 8 years; one 12-in. type gun with ammunition, $88,592, and 29 service guns at the same price each, to be delivered in 8 years. South Boston Iron Works, one 8 in. gun, $27,300; 350 rounds of ammunition, $24,332; 24 service guns, $20 605 each, deliveries to begin in 1894, and to be made at the rate of 6 per year; one 10-in. type gun, $60,560; ammunition for the same, $43,350; 49 service guns, $47,700 each, to be delivered 5 each year after 1895; 12-in. type gun, $100,000; ammunition for same, $60,000; 25 service guns, with ten rounds of ammunition, $79,500 each, to be delivered 5 each year after 1896. Bethlehem Steel Co., 8-in. type gun, $43,893 delivered in ..,460 days, and $42,035 if delivered in 2,190 days; 24 service guns of same kind at $19,723 each delivered in 552 days, or $17,246 if delivered in 730 days; 10-in. type gun, $78,937 delivered in 699 days, or $73,755 delivered in 882 days; 49 service guns of this size at $40,929 each, delivered in 2,130 days, or $37,754 delivered in 3,404 days; 12-in. type gun, $113,951 delivered in 791 days, or $106,558 delivered in 1,095 days; 24 service guns of this size at $61,846 each delivered in 2,033 days, or $54,473 delivered in 3,194 days. The act of Congress gives authority to divide the awards; their longest periods of time the Bethlehem bids are the lowest in each class and their lowest total of $3,785,850 for the 100 guns is the only one within the limit of the appropriation. The total of the Midvale bid is $5,352,500, and of the South Boston bid $5,174,312.

THE LONG ISLAND R. R. TERMINALS at the Flatbush Ave. Station in Brooklyn, N. Y., are to be improved at an expense of $250,000. All the necessary plans have been prepared by CHAS. M. ROGERS, the consulting engineer of the road, and the company has applied to the Common Council for the permission necessary to begin work. The work includes the construction of a two-story freight and passenger station, 120 ft. × 70 ft., the ground floor of which will accommodate the freight trains, and the second story the passenger trains and the necessary elevated tracks for the passenger traffic. The station will be of iron, and will be connected by an elevated pathway with the Union Elevated Railway. The elevated structure will be of steel and will begin at a point between Vanderbilt and Clermont Aves. for the westbound track and between Carlton Ave. and Cumberland St. for the eastbound track. There are now about 375 passenger and 8 freight trains entering the station daily.

EDUCTIONAL VS. WAR EXPENDITURES are discussed by Mr. S. W. HANAUER, an American writer, in the *Revue Liberale*, in an article contrasting the economical and political projects of Europe with those of the United States. Taking only the statistical portion, we find Germany expending about $10,000,000 on schools (exclusive of universities, which are maintained by fees) and $185,000,000 on the army and navy. In Austro-Hungary the army and navy cost $34,500,000 per year, while $6,250,000 is devoted to schools. Italy spends $90,000,000 on war and $4,000,000 on education. France allots $21,000,000 to schools, but expends $151,000,000 on military and naval affairs. Russia's quota is $17,000,000 for schools and $200,000,000 on war. England sinks $156,000,000 in her army and navy and less than $24,000,000 on schools. Spain presents the lowest proportions of all, or $100,000,000 annually devoted to war and $1,500,000 to education. From these figures Mr. HANAUER argues that in the twentieth century Europe cannot hope to compete with the United States in economical pre-eminence or political power.

THE USE OF AMMONIA AS A MOTIVE POWER, or rather to effect a saving in fuel of from 35 to 50%, as claimed, is being tested on the tug *E. D. Hartley* in New York Bay. This boat is fitted with the ammonia patents owned by the Campbell Engine Co. Ordinary aqua-ammonia is used, in combination with water in the ratio of 15 parts of ammonia to 85 parts of water. The tug has been run with this ammoniated water since April 1, and the inventor claims that nearly twice the work is obtained from the same amount of coal used with water alone, and that corrosion is counteracted. It is said that a line of boats will soon be built fitted with this apparatus.

THE PRINCE EDWARD ISLAND TUNNEL has been adversely reported upon by the Government Party in the Canadian House of Commons. The report of Sir DOUGLAS FOX to the Canadian Government gives the following details in addition to those published some time ago. The tunnel is projected to run under the Straits of Northumberland, connecting the shores of New Brunswick with those of Prince Edward Island. The eastern terminus of the tunnel is to be at Carleton Point. Its length will be about 13,500 yards exclusive of approaches, of which about 2,000 yards will be in the tunnel. The greatest depth of water is 96 ft. at high water, with a rise in tide of 6 ft. at the maximum spring tide. The shores are about 25 ft. above high water, the soil being largely red clay. It is considered that about 5½ miles of railway, including approaches will be required to connect the tunnel with the railways at either end. Sir DOUGLAS FOX recommends an internal diameter of 18 ft., and estimates the cost, including approaches, at $10,825,000, or excluding approaches at $8,404,000. This estimate includes a brick lining 22½ in. thick where work is dry, and where feeders occur cast iron casing 15 ins. thick, with 9-in. flanges, and a standard gage railway track laid with 70 lb. steel rails. The tunnel, if built as projected, would be 9 miles long and the longest railway tunnel in the world, with the exception of the St. Gothard, which would exceed it by one-half a mile.

IN THE ALUMINUM LITIGATION, carried on for some time between the Cowles Electric Smelting and Aluminum Co. and the Pittsburg Reduction Co., United States Judge RICKS, of Cleveland, O., has refused for a second time the application of the Pittsburg company for an injunction to restrain the Cowles Company from making pure aluminum at its Lockport works. On July 13, United States Judge SWAN, of Detroit, extended the time for taking the Cowles testimony 60 days, on the ground that the case involves some of the most important issues that have ever come up in a patent case in the Western courts. These suits and counter-suits practically involve the absolute monopoly of the present commercial systems of aluminum manufacture in this country.

THE CITY & SOUTH LONDON RY, the lately opened underground electric line in London, on a total authorized capital of $5,125,000, shows an income for the last half year equivalent to $200,000 per annum. This income is showing decided symptoms of increase, and 3,000,000 passengers have already been carried. The established fare for all classes was 2d., or 4 cts., but lately this has been reduced at certain hours, with a marked resulting increase in traffic. The estimated annual expenses of all kinds amount to $140,000. This is sufficient to pay interest on the $1,125,000 of debentures, and leave a small profit for shareholders.

THE CHIGNECTO SHIP RAILWAY is to be finished in 1893, and the flying rumors to the contrary are officially denied. The present status of the work is thus given in the *Daily Sun*, of St. John, N. B.: At the lower end all the masonry for the lifting docks etc., will be finished in September next. Less than two miles of the railway remain to be completed, and a large force is at work on the line; 13 miles of track are now laid, out of the total 17 miles, and this is in great part ballasted. At the upper end work is not quite so far advanced, but can be all finished before 1893. From a more official source still we learn that all the machinery for the hydraulic lifts is delivered, and the ships' cradles are ready for shipment from England. The Canadian government has extended the time of completion to July, 1893, and the subsidies from that source are thus secured.

PERSONALS.

Mr. R. M. CLAYTON has been re-elected City Engineer of Atlanta, Ga., for a term of two years.

Mr. M. R. SEAL has been appointed Assistant General Manager of the Bellaire, Zanesville & Cincinnati R. R., with office at Bellaire, O.

MR. ARTHUR PEW, M. Am. Soc. C. E., has been appointed Chief Engineer of the Seaboard Construction Co., with headquarters at Savannah, Ga.

Mr. GEORGE C. HALSTEAD, Civil Engineer, and for some time Director of the Board of Chosen Freeholders of Passaic Co., N. J., died at Paterson, N. J., last week.

MR. J. R. KENLY has been appointed General Manager of the Atlantic Coast Line R. R., vice Mr. H. WALTERS, resigned. The name was incorrectly given as Mr. KELLY in our last issue.

Mr. CHARLES H. MYERS, M. Am. Soc. C. E., and for 25 years connected with the Department of Sewers of the City of New York, has opened an office for consulting practice at 63 Bleecker Street, New York. Sewerage and drainage are his specialties.

Mr. A. R. T. LACKIE has resigned his position as Resident Engineer of the Baltimore Belt R. R. tunnel, to accept that of Chief Engineer of the Baltimore Forwarding & R. R. Co., to carry out the extensions and widening of gage of the Baltimore & Lehigh R. R.

Mr. H. R. WHEELER, Engineer in Charge of the Zig-Zag tunnel on the New York, Ontario & Western Ry., met with an accident July 10 at the north end of the tunnel. He was struck on the neck and knocked insensible by two crowbars thrown from a passing construction train, but will probably recover.

The Connecticut State Board of Civil Engineers, appointed July 1, is composed of the following members, all of whom were re-appointed with the exception of the last: Mr. WM. O. SEYMOUR, Ridgefield, Conn.; Mr. T. M. MCKENZIE, Southington, Conn.; Mr. N. J. WELTON, Waterbury, Conn.; Mr. H. B. POTTER, Norwich Town, Conn., and Mr. H. G. SCOFIELD, Bridgeport, Conn.

Hon. JOHN B. PACKER, who died at Sunbury, Pa., recently, was born in 1824, and at the age of 15 was employed on the survey of the Wicomisco canal, and later on the State's exploration of the route between Harrisburg and Pittsburg, on which was afterward built the Pennsylvania R. R. He was elected to the bar in 1844, and to the House of Representatives of the Pennsylvania legislature in 1849 and 1850. While a member of the legislature he succeeded in having the bill passed incorporating the Susquehanna R. R. Co., now the Northern Central R. R. Co., and he was instrumental in getting the road built.

NEW PUBLICATIONS.

—*The Polar Planimeter.*—A manual by WM. COX. 20 pp., 8vo. published by Keuffel & Esser, New York. Price 10 cts. This is a handy pamphlet, in a neat but cheap form fully describing the method of using this labor-saving instrument. It is illustrated with diagrams and examples are worked out in a manner so plain that all can understand.

SOCIETY PROCEEDINGS.

International Congress of Geologists.—The Fifth Geological Congress will be held in Washington from Aug. 26 to Sept. 2 at the rooms of the Columbian University. The President, Dr. J. T. Newberry, and the Secretaries of the Committee of Organization, Messrs. W. T. Williams and T. F. Emmons, cordially invite members of the American Society of Civil Engineers to become members of the Congress and join in the deliberations and the subsequent excursions. Reduced fares (one and one-third rates) can be had on all the principal railways. Hotel rates will also be reduced to members of the Congress. Extensive excursions, as far West as Salt Lake City and the Yellowstone Park, have been planned. Further information can be obtained of Prof. T. F. Emmons, 1330 F St., Washington, D. C.

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AND

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GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Engineers' Society of Western Pennsylvania.—July 21. Secy., J. H. Harlow, Pittsburg, Pa.

Denver Society of Civil Engineers.—July 23. "Canals and Irrigation." Secy., Geo. H. Angell.

Association of Engineers of Virginia.—Summer meeting, July 23-25, at Virginia Beach. Secy., H. W. Newby, Roanoke.

American Society of Swedish Engineers.—Aug. 1. At 250 Union St., Brooklyn and 347 North 9th St., Philadelphia.

Civil Engineers' Society of St. Paul.—Aug. 3. Secy., C. L. Annan.

Western Society of Engineers.—Aug. 5. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of St. Louis.—Aug. 5. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Engineers' Club of Minneapolis.—Aug. 6. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Aug. 7. Secy., E. K. Smoot, 803 Commerce St.

Technical Society of the Pacific Coast.—Aug. 7. Secy., O. von Geldern, 819 Market St., San Francisco.

Engineers' Club of Kansas City.—Aug. 10. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—Aug. 11. Secy., Parker N. Black, 39 Capitol Block.

Civil Engineers' Club of Cleveland.—Aug. 11. Secy., A. H. Porter, 59 Euclid Ave.

Civil Engineers' Association of Kansas.—Aug. 19. Secy., J. C. Herring, Wichita, Kan.

Engineers' Club of Cincinnati.—Aug. 20 Secy., J. F. Wilson.

Scandinavian Engineering Society of Chicago.—Aug. 20. Secy., T. G. Philfeldt, 118 Adams St.

FROM the press reports of the meeting of the Western Traffic Association on July 14 and 15 the principal feature of interest seems to have been the appearance of Mr. RUSSELL SAGE, the Wall Street magnate and President of the Iowa Central, without his beard. The really important feature of the meeting of the Association, however, was what it did not do; and what it did not do was to approve of Mr. GOULD'S plan for the establishment of joint agencies at competitive points. At the meeting reported in our issue of May 16 the Association directed its Commissioners to prepare and present a plan for the establishment of such joint agencies; but we then pointed out that while the establishment of such agencies was well-nigh essential to the life of the Association, a very strong opposition would have to be overcome before the move would be successful. At the meeting this week the opposition seems to have mustered its forces, and the subject of joint agencies was quietly shelved until the October meeting.

THE Chignecto Ship-railway has not suspended operations, as was reported in Halifax dispatches and mentioned in our issue of July 11. We have the best of authority for saying that while there has been some delay in raising funds, owing to the present complications in the London financial market, an extension of time to July 1, 1893, has been granted, and the work is going ahead vigorously. The contract with the Canadian Government is in nowise affected, and owing to the extension of time the subsidy is still available. We give further details in our Engineering News columns, and, meanwhile, make this correction of a prevalent rumor as conspicuous as possible. The completion of this first ship-railway, and its successful operation, will doubtless put life into more than one similar enterprise now only awaiting this event, and the Chignecto enterprise is thus to be congratulated upon its relief from its temporary embarrassment.

THERE seems to be as much of the unexpected in the late census of Great Britain as in our own of 1890. The returns are not all in yet, and changes in returns sent in are frequent, but the following appears to be about the general result: England and Wales now have, in round numbers, 29,000,000 inhabitants, against 25,974,439 as given in "Whitaker" for 1881. This is less than was expected by about 900,000. The list of "28 large towns" shows a gain of nearly 1,000,000; but this is less by 600,000 than the figure based upon the rate of increase in the previous 10 years. London itself still shows a marked decline in its rate of growth. This decline commenced in 1851, the rate being 19% in 1851-61, and 10.4% in 1881-91. In 1881 the City of London, in its area of 668 acres, had a fixed or night population of 50,652. the last night census taken shows 38,345 actual residents and a population of 300,000 in business there during the day. The population of the metropolis of London, covering 75,334 acres, is now 4,211,056, as compared with 3,816,483 in 1881.

NOTWITHSTANDING the fact that the decision upholding the validity of the Edison patent on incandescent lamps, elsewhere described, will probably increase the price of incandescent lamps and transfer several millions of dollars from the pockets of the public to the treasury of the Edison Electric Company, it is quite possible that it may be on the whole for the public benefit. There seems to be a growing sentiment that the protection afforded by a patent does not amount to much; and that the delays and difficulties which a shrewd patent lawyer can interpose to protect an infringer are more cheaply purchased than a license under the patent. This is certainly an unfortunate state of affairs. The law makes a patent a species of property, and provides machinery to protect it. If that machinery can be so obstructed that the infringer who takes property not belonging to him can escape punishment and avoid restitution, then the tendency certainly is to lower the standard of commercial morality.

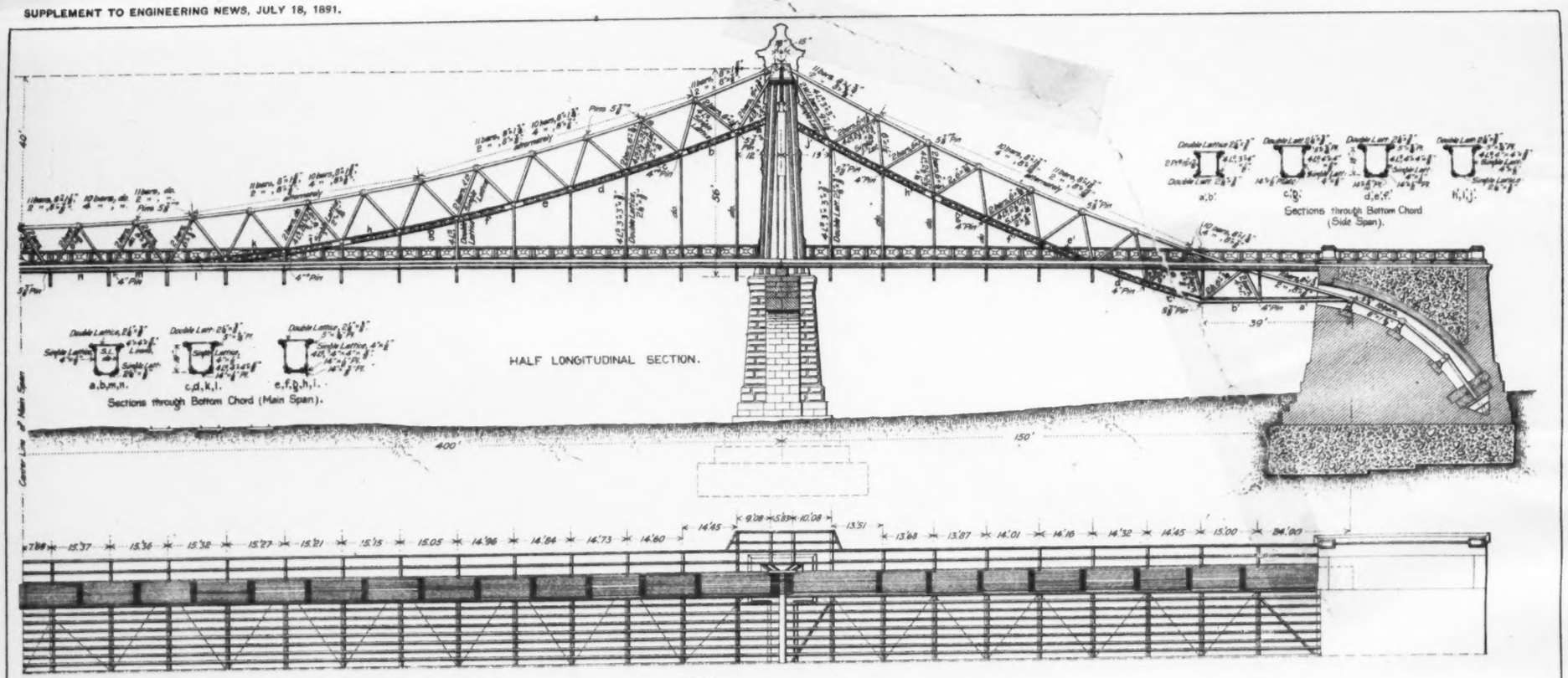
We venture no opinion on the merits of the present case. Doubtless there were valid arguments in favor of both sides, and certainly Edison had some grounds for his broad claim to the combination of carbon filaments, glass receiver exhausted of air, and electric conductors passing through the glass. That this claim has been finally sustained after 11 years of infringement and 6 years of litigation cannot but increase to some extent public respect for property rights in patents, and the law which protects them. Defects in the patent laws, and in our patent system certainly exist; but on the other hand their benefits are equally certain, and while these laws remain in force they should not be allowed to become dead letters.

THE serious accident in Colorado this week, in which a passenger car was wrecked against the front end of a locomotive and its occupants were scalded by the escaping steam from the broken injector-check valve on the front end of the boiler, may perhaps inspire Mr. CHAUNCEY DEPEW or some other authority on car heating to further utterances on the dangers of car heating with direct steam. We are not now informed as to the size of the opening made in the boiler in the Aspen Junction accident. If the check valve was torn out of the sheet, as would be quite probable, a hole of considerable size would be made. In the Quincy disaster last August, in which a crowded passenger car was turned on its side against the rear end of a wrecked engine, the blow-off cock was torn out of the sheet, leaving a hole about 2 ins. in diameter, and the injector pipe was also broken off. The steam and hot water instantly poured into the car in great volumes; and as the upper side of the car remained nearly intact the steam was pretty well confined in the car, yet passengers who were able to move escaped without dangerous scalding; and in the Colorado accident, although the car was filled with steam, only the passengers close to the escaping steam were seriously injured by it.

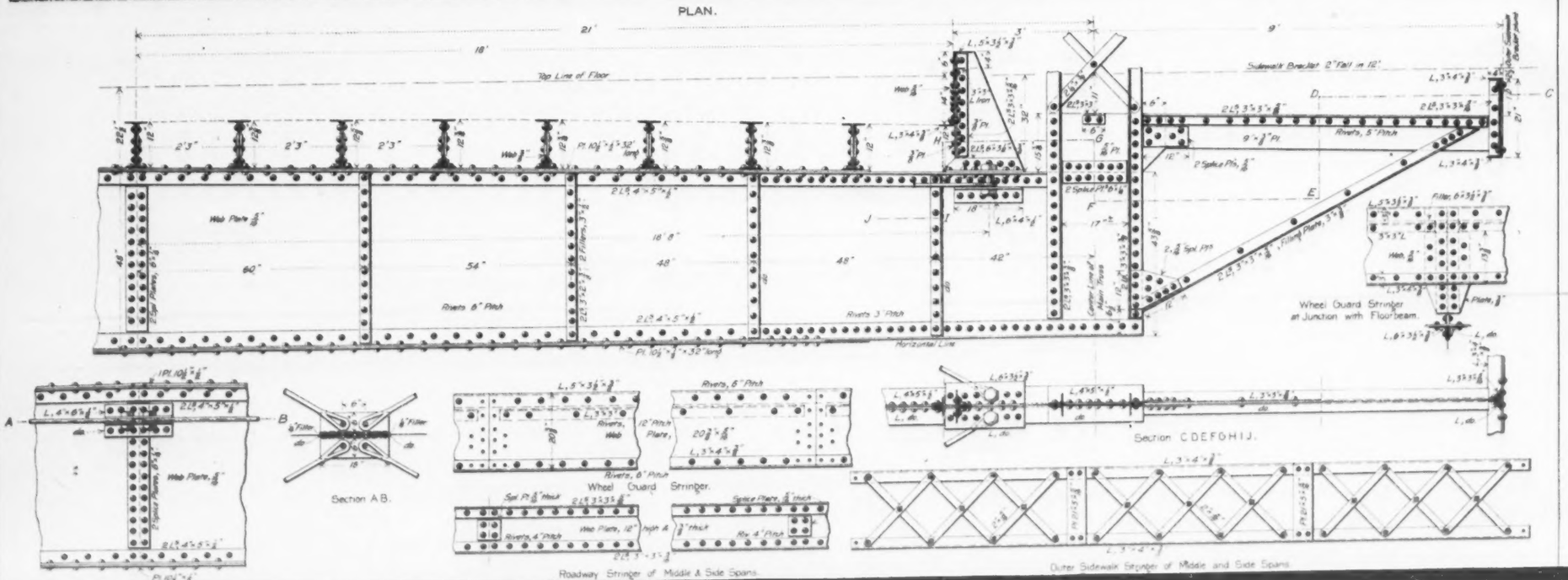
As engineers are well aware, the amount of steam which would escape in a given time from an opening directly into a boiler, such as that which caused the scalding at Aspen Junction, at Quincy and at Mud Run, on the Lehigh Valley, two years ago, is enormously greater than that which would escape from any possible break in steam-heating pipes on a train. If a break should occur in a steam pipe in a car, even if it be next to the engine, the friction of the steam in passing through the pipe greatly reduces the outflow from the break, and the volume escaping is comparatively small, as experiments have fully proved. Only in a small, closed compartment is there any probability that the volume of escaping steam from a heating pipe could be great enough to be dangerous.

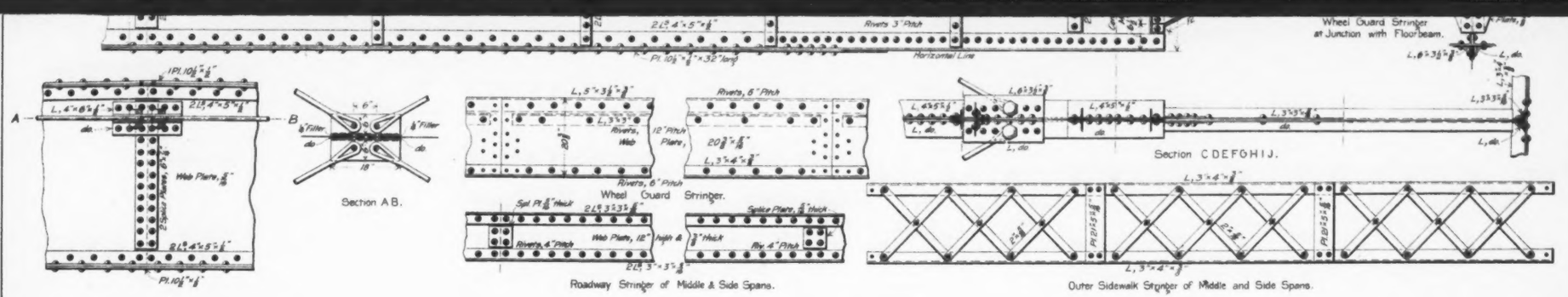
The amount of exposure to escaping steam which persons can endure without injury is well shown by the number of people who escaped uninjured at Quincy and at Aspen Junction after remaining for some time in the steam-filled car. Hot-water heating has been proved superior to steam in point of comfort; and if the idea that direct steam is dangerous helps the better system into use it will not do much harm. But to try to defend the car stove on the plea that steam heating is dangerous is not likely to be very successful with the general public, and especially not with engineers.

THE investigation of the Ravenna collision by a coroner's jury seems to show that the rear flagman was not so neglectful of duty as was at first reported; but it strengthens rather than weakens the statement that the necessary safeguard against

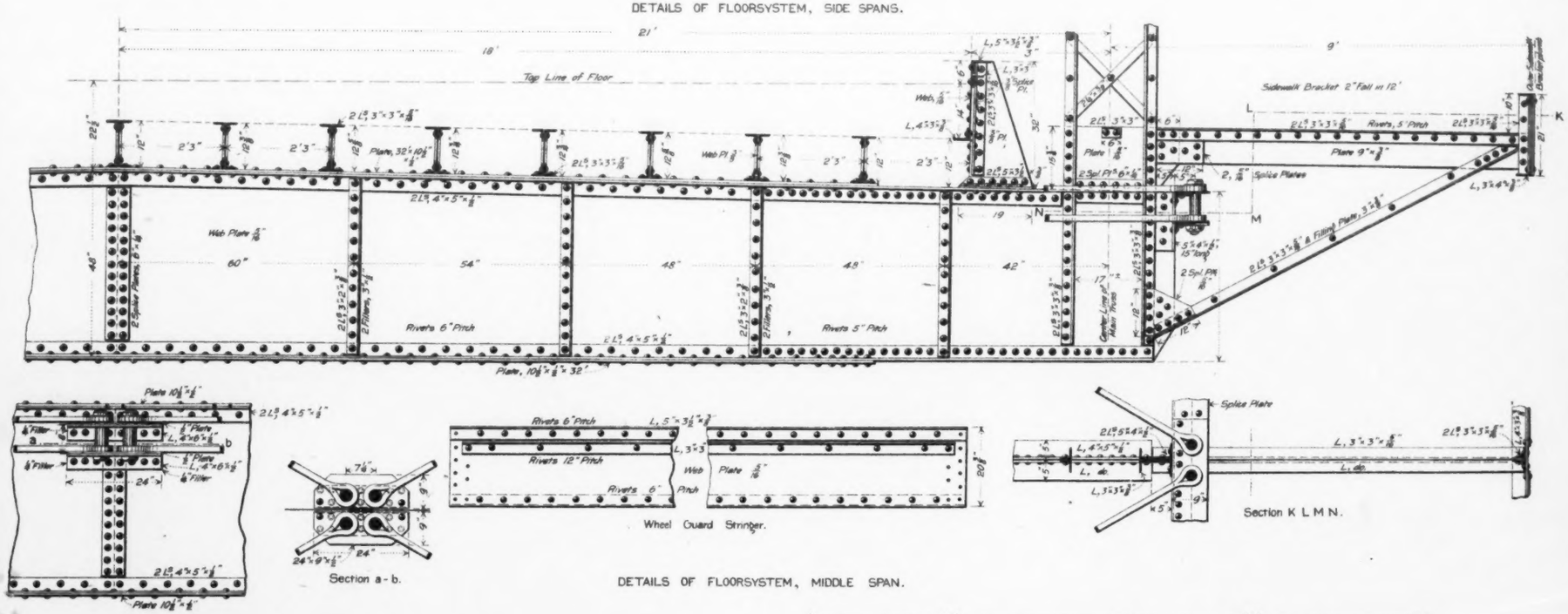

HALF LONGITUDINAL SECTION.
Sections through Bottom Chord (Main Span).
a,b,m,n.
c,d,k,l.
e,f,g,h,i.
Sections through Bottom Chord (Side Span).
a,b'.
c,g'.
d,e,f'.
h,i,j.
Center Line of Main Span
400'
150'
39'
40'
56'

PLAN.

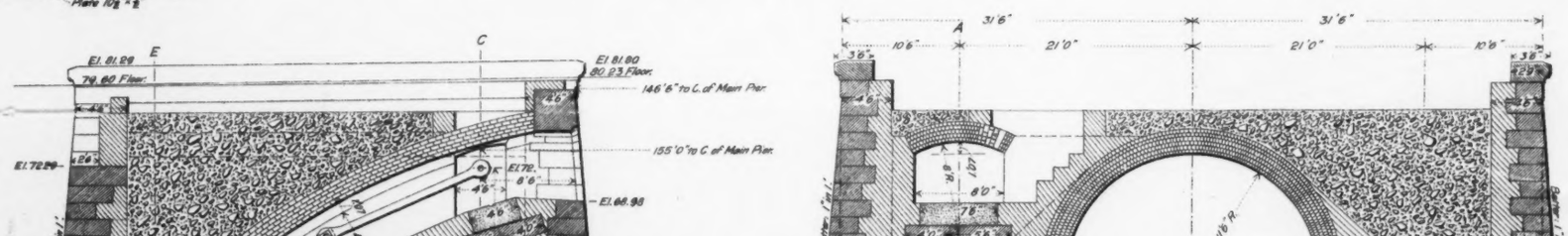

Top Line of Floor
Sidewalk Bracket 2" Fall in 12"
Wheel Guard Stringer at Junction with Floorbeam.
Section A B.
Wheel Guard Stringer.
Roadway Stringer of Middle & Side Spans.
Section C D E F G H I J.
Outer Sidewalk Stringer of Middle and Side Spans.

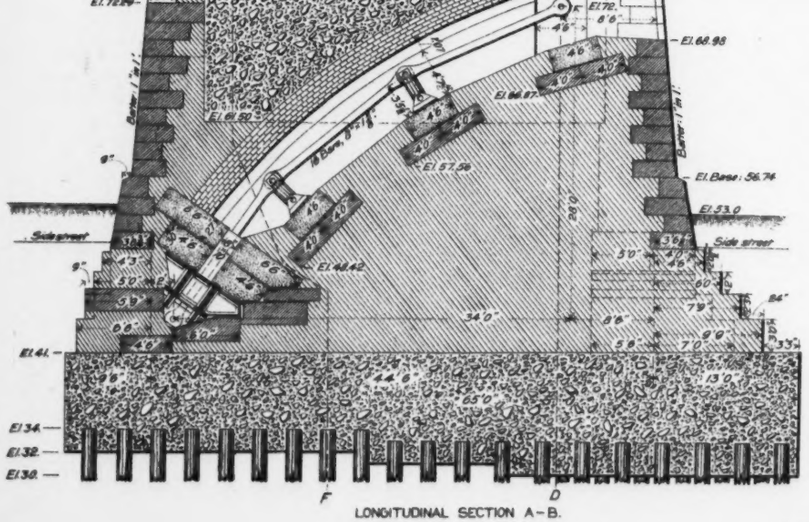

Wheel Guard Stringer at Junction with Floorbeam.
Section A B.
Wheel Guard Stringer.
Section C D E F G H I J.
Roadway Stringer of Middle & Side Spans.
Outer Sidewalk Stringer of Middle and Side Spans.

DETAILS OF FLOORSYSTEM, SIDE SPANS.

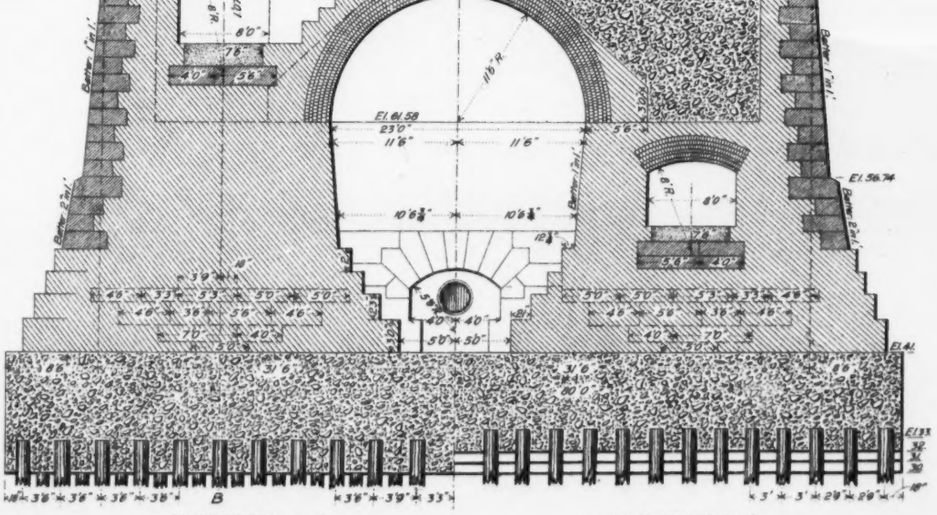


DETAILS OF FLOORSYSTEM, MIDDLE SPAN.





LONGITUDINAL SECTION A-B.



CROSS SECTION C-D.

CROSS SECTION E-F.

ANCHORAGE.

GRAND AVENUE BRIDGE, ST. LOUIS, MISSOURI.

CARL GAYLER, ENGINEER.

KING IRON BRIDGE & MANUFACTURING CO., BUILDERS.

LITH. CHAS. HART & SONS, 26 VESEY ST., N. Y.

such accidents is the block system. It appears that the fast freight which crashed into the rear of the passenger train left Kent, 7 miles west, close behind the passenger train, and ran at high speed, the engineer probably supposing that the limited through express would certainly keep out of his way. The passenger train, however, ran rather slowly, and when it stopped the heavy freight was only a mile or so in the rear, and running at 30 miles per hour. The cars were Swift's refrigerator cars, and were not fitted with air brakes. As a result the rear brakeman did not have time to get back far before the freight came in sight, and the impetus on the down grade was too great for a sudden stop with hand brakes.

The Standard Code of train rules forbids a train to leave a station to follow a passenger train until five minutes after the departure of such passenger train, unless some form of block si nal is used. This is not a large margin to cover the contingencies which may occur to bring the trains closer together. Whether the engineer of the freight train followed the express in less than five minutes or not, the fact should not be lost sight of that it was the system and not the men which was primarily at fault.

THE probability that the Canadian Government will add to its already grievous burden of unprofitable transportation lines by granting a subsidy of $80,000 per year in aid of the proposed railway and steamship line from Winnipeg, Manitoba, via Hudson Bay and Straits, to England, is rapidly becoming a certainty. Other reasons than those usually advanced for such action, it is almost unnecessary to say, are at the bottom of it. It displays, however, little wisdom in our Canadian cousins. It would be doubtful policy to aid in building a railway through 650 miles of wilderness and establishing a trans-Atlantic line of steamers for the express purpose of saving a few hours in the shipment of grain to Europe, even if such a line could be operated during the entire year. When, however, it can be operated with difficulty and danger for only three months of the year it would seem to stand condemned without discussion. Of course the promotors are fully aware that this subsidy will not go far toward the actual construction of the road; it is to be used merely as a lever to induce capitalists to invest in the scheme. Fortunately recent investigations into the practicability of navigating the waters of Hudson Bay have furnished such information regarding the character and feasibility of the enterprise that there is little danger from this source.

The report of Lieut. ANDREW R. GORDON upon the practicability of navigating the waters of Hudson Bay by vessels engaged in commerce, and upon the natural resources of the country tributary, which has recently been presented to the Canadian Government, contains some interesting information touching upon this point. Lieut. GORDON made two voyages aggregating three years in duration, during which time he made an exhaustive study of the resources, and of the climatic and hydrographic nature of the region.

IN estimating the period of navigation of an ordinary year the report states that it extends from July 15 to October 15, with the possibility of an additional month during especially favorable years. From November to April inclusive the Hudson Strait is closed with ice, and during May, June and July large quantities of ice are present. During the entire year icebergs are formed in Hudson Bay, and from November to July inclusive there is much floe-ice varying in thickness from 4 ft. to 8 ft. The tidal currents are very rapid and dangerous at the eastern end of Hudson Strait, and a vessel becoming entangled in the running ice in these currents is sure to meet with hard usage if not actual disaster. The resources of the country are very limited. The fisheries are the only industry, and these are carried on by small vessels from Canada and the United States which winter in the bay, and by the agents of the Hudson Bay Co. The inhabitants are the Esquimaux hunters who work for the Hudson Bay Co. or derive a precarious existence by trapping and fishing. In summing up, the report states that navigation is well-nigh impossible on account of the magnetic nature of the region even if there were no ice.

The net income from the operation of the projected line, with such conditions, can better be guessed than estimated. It would seem too much of an *ignis fatuus* to lure even the guileless "foreign capitalist" into investing in the scheme.

The State Inspection of Railway Bridges.

Twenty-five states in our Union now have boards of railway commissioners, doing more or less effective work in caring for the safety of the traveling public, and especially in the West, paying more or less unbiased attention to transportation rates and the relation of railway corporations to the people of these states. Each of these boards necessarily, but in different degrees, pays some attention to the bridges and trestles on the railways of their respective states, structures responsible for a large proportion of fatal railway accidents. But none of these boards, in this connection, have done as efficient work as that of the State of New York in its recently issued "Report on Bridge Strains." We say efficient work advisedly, for while similar data have been collected by other states, particularly by Massachusetts, New York has been the first to make this information public, and there is a moral effect in this publication of the good and bad points of railway bridges that is quite as potent for reform as any legislation that could be enacted.

Under the act of 1882, forming the present Board of Railway Commissioners for New York, its officers are authorized to demand from every railway corporation in the state detailed plans, sections and strain sheets of every bridge structure on their respective roads. These plans are inspected by a competent bridge engineer, and when the case seems to demand it or the bridge is not above suspicion, a personal inspection is made by authorized agents of the board. If any bridge does not come up to established standards, the loads liable to come upon it being duly considered, the railway commissioners can cite the corporation owning such bridge to show cause why it should not be rebuilt or repaired.

The effect of this official warning is two fold. In the first place, at least some effort will at once be made to correct the defects pointed; for it would be financially fatal to the company to have any accident happen from a defective bridge, of the faults of which they had been officially notified and the design and sections of which were on record. And secondly, the fact that these strain-sheets and plans are demanded requires the officials of the railway to overhaul bridges practically forgotten, and this search would often develop defects of which they themselves were previously ignorant, and they themselves recognize certain bridges as dangerous by repairing or rebuilding before the demands of the board are complied with. These facts are apparent in the report before us, where the statement is made that since the creation of the board, about nine years ago, 669 bridges have been criticised officially as showing some inherent weakness from faulty design, bad workmanship or decay of material; and of this total 134 bridges have been entirely rebuilt, and the remaining 535 have been more or less efficiently repaired. The board also states that "a large number of bridges have been repaired or rebuilt before the strain-sheets were submitted;" proving either that the attempt to comply with the state requirements developed trouble that the company themselves were ignorant of, or that the railway officials, with false ideas of economy, had been deferring repairs as long as possible.

In this actual inspection of structures, coupled with the power to practically demand repairs, the board has evidently done a good work, as is plain from the record above given. But in this line of proceeding the board is limited to the condemnation of bridges that can be proven faulty or weak; in other words, it is the worst bridges only that are affected among hundreds of others that have outlived their usefulness. A board of directors, especially on a minor road, may yield unwilling obedience to an official order to repair or rebuild any particular structure, after it has attempted to argue that the bridge was "strong enough for the traffic upon it," as happened in more than one case in New York. But in these enforced repairs it also too often happened that the least money possible was expended upon these repairs and they were purely temporary in character. Other bridges on the line, not quite so bad, but too bad to exist on a modern railway, are severely left alone.

It is here that the publication of this diagram of of the truss, the strain sheets and criticism of the design and a statement of the method of repairs come in. As long as the State Board and the directors of the road were alone cognizant of the facts of this case, and some understanding had been arrived at between themselves and the structure made at least temporarily safe, the directors could fall back to their old-time lack of care and wait for another official warning. But the case is materially altered when the public is let into the secrets of the state and the corporation, and every one interested can criticise for himself all of the structures on any railway in the state. Public opinion is a weighty factor in bringing about reform in any cause, and this can best be cultivated by giving the facts to the public and allowing it to think and act for itself. Self-interest in the party of the second part, which originally led to the saving of money as long as its expenditure could be deferred by concealing the need for this expenditure, will be just as potent for reform in this respect when reform is demanded by a public recognition of the fact that safety for human life is not so well cared for on some roads as upon others.

Human life is just as precious on a branch road a few miles in length as it is upon one of the great trunk lines; and those in authority over each must be held equally responsible. We cannot, of course, look for the same perfection of roadbed, and the appurtenances belonging to it, in the minor or financially weak railway; but every structure upon such a road should be proportioned to safely carry the heaviest load that is liable to pass over it, and there should be no doubt about this point. The "Report on Bridge Strains" shows that railway trains are daily passing over wooden bridges in this state built in 1849, and of a design so complicated that no engineer can figure out the distribution of strains between arch and truss members. The line of the Ogdensburgh & Lake Champlain Ry. is now a veritable museum of antique wooden railway bridges; and while the collection is interesting as an object lesson, in showing the methods adopted in the early days of railway building in this country, they have long outlived their usefulness, and are a disgrace to any corporation in the light of present engineering practice and knowledge. On this road are to be found deck trusses of the Burr type, 44 ft. in span and 4 ft. 4 ins. rise, old King and Queen trusses, spur-braced bridges up to 63 ft. span, and nondescript specimens that belong to no respectable family of bridges. The report also shows, in this and other cases, how bridges that should be pulled down are repaired by supplemental piers under the spans and by props and braces. This work has been done by order of the state, and done in this

way, in many cases, because the roads were too poor to pay for efficient work; but prior to these enforced props it would seem that some of these bridges must have carried the load imposed upon them "by sheer force of habit," as a well-known engineer once aptly explained a similar case of survival.

Speaking of old bridges, we note in this same report that one of the oldest iron railway bridges in this country is still in daily use at Utica, N. Y., over the Mohawk River. It was designed by SQUIRE WHIPPLE and erected over 30 years ago. It is a single-track span of 123 ft. 2 ins. on the trapezoidal plan described by Mr. WHIPPLE himself in ENGINEERING NEWS of April 7, 1888, in speaking of a similar bridge at Troy, N. Y., which was then being taken down. Its existence and capacity for useful work at the present day is creditable alike to its designer and to its builder. Even with modern engine and car loads, which are about double what they were when the bridge was designed, the maximum strain in a web member is 13,165 lbs. per sq in., and the greatest strain in the lower chord is 12,566 lbs. It was an experiment in bridge building, and aroused much discussion at the time, and was roundly condemned by some engineers; and, as was quite natural under these conditions, it was made a little too strong for the work then to be performed and almost strong enough for the increased traffic of another and succeeding generation. But in consideration of the rapidly increasing loads put upon it in the last few years the board recommends that it be replaced by a more modern type of bridge. It should be preserved somewhere as the work of a pioneer in a type of iron bridge that has since made American bridge engineers famous.

In discussing this "Report on Bridge Strains" it is only fair to state that its preparation has been the work of some years, and that it is necessarily not up to date in all cases; in other words, a number of the trusses here shown have been since replaced by new bridges, though this fact is noted in the report. While the work performed by Mr. WILLIAM E. ROGERS, the Chairman of the Board of Railway Commissioners, and Mr. CHARLES F. STOWELL, the Bridge Engineer of the board, is a monument to their intelligent labor and patience, we cannot but regret that they did not go still further. Plate-girder bridges and trestles are not included in this report, and there is no classification of structures or summary of types, materials and aggregate length. In a very rough count made in leafing over the 1,900 pages of the report we find that there are still about 360 wooden railway bridges of considerable span in use in the state. This is about 14% of the number of existing bridges of all classes, as compared with 35% for Massachusetts and 27% for Ohio, the only other states for which we have statistics just at hand. In New York the bulk of the wooden bridges are of the Howe truss type, and, while they are usually found upon lines of secondary importance, the report shows that some still exist on roads as prominent as the New York, New Haven & Hartford, and on the New York, Ontario & Western railways. There are 35 wooden bridges out of 90 truss bridges on the latter road.

The State of Massachusetts had in 1890 a total of 1,658 railway bridges of all classes, as compared with about 2,500 for the State of New York, but the Railway Commission of the first-named state has caused 531 bridges, or about 32% of the present total, to be repaired or rebuilt since the formation of the board, in 1887. Of this total of 531, 354 bridges were entirely rebuilt and 177 were extensively repaired. Compared with the record for New York State already given, this shows either that the Massachusetts bridges were in a deplorable condition before the advent of the Railway Commission, as might be expected from the predominance of wooden structures, or that the Massachusetts Commission was clothed with greater power and enforced it vigorously. It is probable that a mixture of both causes had something to do with the general result; but it is evident that the Massachusetts Commission has been doing very good work in this direction. In almost exactly 4 years it has caused the improvement of 531 insufficient railway bridges in that state, and has rebuilt 354 of these entirely. The New York board in about 9 years has improved 669 railway bridges, but has only caused 134 of these to be rebuilt. We also find that Massachusetts spent $943 347.86 in 1890 for the rebuilding of 64 bridges and the extensive repair of 43 others, so that the proportion of new bridges to repaired structures is still being kept up in that state.

Without going into further detail the renewal of exactly 1,200 defective railway bridges in less than 9 years by two boards of state railway commissioners out of all our states is alone sufficient to prove what invaluable work can be performed by such commissions when they honestly labor for the increased safety of the traveling public. No one can more than guess at the total of life and property saved by this action and the amount of human misery thus avoided. The railway commissioners in many of our western states, we are sorry to say, seem to think that the chief end of their existence is to secure lower rates for transportation; and if they do efficient work in the lines pointed out above it makes but little showing in their reports. In many of the states west of the Alleghanies wooden structures still are too plentiful, and these especially need watching, and yet of all structures they receive the least notice as a rule. The State of Ohio, for example, lately had 68,425 lin. ft. of wooden bridges and 433,522 lin. ft., or about 82 miles, of wooden trestlework, as compared with 83,923 lin. ft. of iron bridges. California in 1 89 had 1,391 wooden bridges and 36 iron bridges, with an aggregate of 388,500 lin. ft., or 73.5 miles, of wooden trestles. Iowa had in the same year 61,100 lin. ft. of wood and combination truss bridges and 205 miles of wooden trestle and pile bridges. Other states would show similar records were the data available, and all of them undoubtedly need the services of a state commission clothed with the same or even greater power than those of New York and Massachusetts, and with its attention turned toward the saving of human life rather than the saving of fractions of a dollar in freight rates.

As an example of the different methods of performing their duty, we can mention that the Iowa railway commissioners, in their voluminous report of 1889, never mention railway bridges once, in the 1,100 pages of that report, that we can discover. The Oregon board expresses the purpose of its being in the following sentence quoted from its last report: "In this way the transportation companies and corporations assumed and arrogated to themselves the power to establish and enforce rates for their services, at first denying to the people and the state any power or right to interpose in any way for the relief of those doing business with them, or to question the reasonableness of their charges or to revise or modify them in any case." In the list of questions submitted by this board to the railway corporations there is no mention whatever of bridge structures, though, as the board is of very recent creation, it may not have reached that point as yet. The reports of other Western States express similar views, and while they minutely discuss rates, expenses of construction and maintenance, etc., and suggest methods whereby the dividends to stockholders may be reduced, they allow the railways to manage their bridge structures as they may see fit, and bid for neglect in this direction by imposing burdens upon the corporations that react upon the maintenance account. If two of the oldest, longest settled and wealthiest of our states, having within their boundaries some of the richest and best managed railways in the United States, can find 1,200 defective railway bridges in nine years, what would be the record of condemned railway structures in some of the other states mentioned? We leave the public to answer the question, trusting that their desire for personal safety will compel the state authorities to pay more serious attention to the rigid official inspection of all railway structures.

CORRESPONDENCE.

Work on the Ontario & Sault Ste. Marie Water-Power Canal.

SAULT STE. MARIE, Ont., July 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

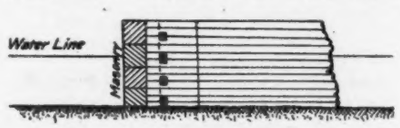
SIR: The Water Power Co. has obtained the Government land required to develop the power as contemplated. Col. J. T. Fanning, Consulting Engineer, has been on the ground and started the work, which is being prosecuted with vigor. Luke Madagan & Co. have sublet the dredging to Weppi, Macdonald & Ward; the solid rock excavation to James Madagan & Co., and the mixed materal to Bruce & Co. The work on the head race is being pushed actively by the sub-contractors. There are about 175 men with 40 teams and one dredge at work. The solid rock excavation is taken out 80 ft. wide and deep enough to insure 14 ft. of water at the head race. The stripping of the solid rock is 80 ft. wide at the lower end and over 200 ft. wide at the upper. The material taken out is composed of solid and loose rock, sand, clay and gravel, and is used to form two embankments, one about 2,500 ft. long on the south side, to a timber bulkhead and waste weir, and a similar one on the north side about 2,000 ft. long. The material, with the exception of loose rock which is used for riprapping, is placed in 6-in layers and rolled with a 3,000 lb. gravel roller. The embankment is 8 ft. wide on top with an inner slope of 1½ to 1, and an outer slope of 2 to 1. A hydraulic masonry wall with penstocks etc., about 500 ft long will be built on the north side of the head race to the timber bulkhead. Regulating gates with sluceways, etc. will be built at the upper end of the head race to regulate the flow of the water. J. M.

A Stone Cut-Water for Crib.

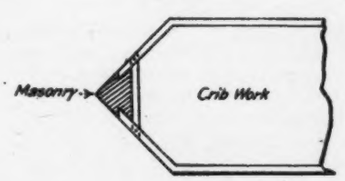
TORONTO, July 5, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Will you kindly give me your opinion on inclosed sketch of a stone cut-water fixed in a crib? The sketch explains itself, but I would add that the stones should



ELEVATION.



PLAN.

be doweled or laid in cement. I think that this would be stronger and cheaper than boiler-plate. By giving me your opinion, you will greatly oblige yours truly,

W. G. WARNER.

[Our correspondent's suggestion is novel, to the best of our information, and is doubtless feasible. But we can hardly agree with him on the plea of economy or greater strength. To stand the shock of ice, drift or possibly a vessel the stones would have to be massive in size and hence somewhat troublesome to handle; and for the same reason they would have to be fairly well cut on all sides and hence be costly. As to strength, the tie at the nose of the crib is lost, practically, and this is the one chiefly to be depended upon to distribute a shock to the body of the crib. Of course, if the stone nose is so well cut as to fairly abut against the tie, it will transmit strain; but not so well we think as the tie at the nose itself. While the dove-tail, doweling and

cement should prevent lifting by ice, the vertical bond is evidently not so perfect as it would be in the well-spiked crib-nose protected by iron plates. In a well made wooden crib, by the by, the iron plates do little more than protect the wood against wear by ice and driftwood.—ED. ENG. NEWS.]

The Bogota Water-Works.

BOGOTA, June 6, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I am reminded that I promised to give you some details about the water works of this city. I will do so as briefly as possible.

Bogata lies partly on a plain and partly on the slopes of mountains to the south and east of the city. Its general altitude above sea level is 8,600 ft. The mountains back of it rise some 2,000 ft higher. From the gorges of these mountains come four streams, two of which flow through the heart of the city and two pass through its surburbs. Under the régime of the old Spaniards, *cañarias* and *acequias* of stone and brick and mortar brought water to different parts of the city, supplying the necessities of the population by fountains in the plazas and by open runs in the streets. In 1888 a company got a concession to construct a plant on the modern plan of pipes in the streets. In doing this the company made use of one of the old *cañarias* so far as to take the water from the principal river which passes through the town, named San Francisco, and conduct it along a contour line of the mountain a distance of something over a mile to a point which was chosen as a site for a reservoir. The reservoir was built on the mountain side by terracing its site. It holds about one million gallons of water.

The aqueduct and reservoir stand right above the city and at an elevation above the general level of 80 meters, or about 262 ft. In November last a land-slide took place on the mountain side which carried away about 200 ft. of the aqueduct. The breaking of the aqueduct of course poured a considerable quantity of water down upon the adjacent houses, increased the extent of the land slide and caused quite a disaster, destroying 30 houses, though happily with no loss of life. The land-slide, fortunately, did not include the reservoir, otherwise the disaster would have been magnified many times.

The water service was necessarily interrupted for a time. The company has, however, very ingeniously closed the gap in its aqueduct by suspending two lines of 12-in wrought iron pipe by a cable made of telegraph wire, across the chasm made by the slide. The aqueduct has likewise been tapped at several points between the intake and the break, and at present the service is fairly satisfactory.

But the people, the municipality and the government are alarmed at the standing menace which the aqueduct and reservoir are to a large part of the city. It has hence been determined to recast the whole system of water supply, in the hopes that something may be devised both better and safer than the old system. And for that purpose I was summoned to this city. I have spent just one week in my preliminary studies, and think I see my way toward accomplishing the results desired.

Of this you will hear more when my plans have been matured and put into specific form. Yours truly,

S. H. LOCKETT, Chief Engineer, Bogota Water Works.

Determination of a Meridian *

In the determination of a meridian by the elongation and culmination of Polaris there are generally two, and sometimes three, opportunities for observation during the night; the first opportunity may occur early in the evening or after midnight, depending upon the day and the month. The following method is offered as a substitute for the waiting and watching, requiring but a little calculation, and with a little strategy, dispensing with a night observation. The method is applicable the instant Polaris becomes visible, as well as during the hours considered proper for star observation.

Polaris is now only 1° 16′ 23″ (mean co-dec.) from the Pole and approaching it with an annual rate of 19″ (18″.87). There are no large stars in its vicinity to be mistaken for it, and its rate and direction of motion make its identity positively certain. Its apparent motion around the Pole is so slow that its change in azimuth is less than $\frac{1'}{2}$ for one minute of time south of latitude 47°, or an error of two minutes in time will cause a maximum error at culmination of less than one minute of an arc in azimuth at ordinary latitudes, the error decreasing as Polaris recedes from the meridian. An error in latitude produces its maximum effect at elongation, but an error of 30′ in latitude will not produce 1′ error in azimuth south of lat. 47°. In the following programme first find the hour angle H (see Fig. 1).

* Contributed by W. L. Marcy, Greene, N. Y.

PROGRAM.

To Find the Hour Angle of Polaris.—If the observation is at evening take the R. A. of mean sun, Greenwich mean noon for that day, but for the preceding day if the observation is in the morning; add to this the local time of observation, plus 12 h. if in the morning, and also add the increase in R. A. corresponding to time west from Greenwich and the time of observation, plus 12 h. if in the morning. From these quantities deduct the apparent R. A. of Polaris for the day of observation if an ephemeris is used, or the mean R. A. if an almanac; the remainder t is the time the star is west of the upper culmination, but the hour angle will be estimated from the upper or lower culmination as follows:

For t negative, Polaris is east above Pole, hour ang $t \times 15°$.

For t < 6 h. and > 0 h. Polaris is W. A. Pole, $H = t \times 15°$.

For t < 12 h. and > 6 h. Polaris is W. B. Pole, $H = (12 \text{ h.} - t) \times 15$.

For t < 18 h. and > 12 h. Polaris is E. B. Pole, $H = (t - 12) \times 15$.

For t < 24 h. and > 18 h. Polaris is E. A. Pole, $H = (24 - t) \times 15$.

For t < 30 h. and > 24 h. Polaris is W. A. Pole, H = etc.

TABLE C.

Giving the time when Polaris is due north at its upper culmination.

Date.	Local time for the upper culmination of Polaris, longitude 90° W from Greenwich.
Jan 1, 1891	6 h. 33 min. 23 sec., P. M.
Feb. 1, 1891	4 h. 31 min 00 sec., "
March 1, 1891	2 h. 40 min. 31 sec., "
April 1, 1891	38 min. 27 sec., "
May 1, 1891	10 h. 40 min. 34 sec., A. M.
June 1, 1891	8 h. 39 min. 01 sec., "
July 1, 1891	6 h. 41 min. 31 sec., "
Aug. 1, 1891	4 h. 40 min. 07 sec., "
Sept. 1, 1891	2 h. 38 min. 38 sec., "
Oct. 1, 1891	0 h. 40 min. 54 sec., "
Nov. 1, 1891	10 h. 35 min. 06 sec., P. M.
Dec. 1, 1891	8 h. 36 min. 56 sec., "

The apparent right ascension of polaris for the year 1891 has been used in this table.

The error from using the mean right ascension may amount to about one minute in 1891, depending upon the date.

The difference between apparent and mean right ascension varies from year to year, but the apparent right ascension for 1891 will be the more accurate for a few years.

Add or subtract 11 h. 58 min. 02 sec. to get time for lower culmination.

Let T = time of Table C, n = date of the month, then upper culmination at date n will occur $T - 3$ min. 56 sec. $\times (n - 1)$.

Add or deduct 10 sec. for long. 15° E. (75°) or 15° W (105°) to get time of culmination.

The corrections for subsequent years, on account of precession, etc., etc., are as follows:

1892, 1 min. 2 sec. later until March 1st, then 2 min 34 sec. earlier.
1893, 1 min. 13 sec. earlier.
1894, 08 sec. later.
1895, 1 min. 23 sec. later.
1896, 2 min. 50 sec. later until March 1st, then 1 min. 05 sec. earlier.
1897, 16 sec later.
1898, 1 min. 37 sec. later.
1899, 2 min. 58 sec. later.
1900, 4 min. 19 sec. later. Not a leap year.

Where A = above; B = below; W = west; E = east; or H can be found by Table C by adding 10 seconds to each hour of difference between the local time of observation and culmination; the sum will be the value of H in time.

Secondly, find z, the azimuth corresponding to H. (See Diagram 1.) By spherical trigonometry,

$$\sin z = \frac{\sin H \sin d}{\sin Os}, \quad \sin z' = \frac{\sin H \sin d}{\sin Os'}$$

d being small, l may be substituted for Os, Os', and

$$\sin z = \sin z' = \frac{\sin H \sin d}{\sin l}. \qquad (1)$$

The error from (1) varying with the latitude scarcely exceeds 1′ (1′ 12″) at lat. 45°; $d \cos H$ added to or subtracted from the latitude gives the elevation of s or s' above the horizon.

Having precisely adjusted the focus of the telescope for very distant objects (for parallel rays), then lay off the azimuth z from the meridian obtained by the magnetic variation and set the vertical arc for s. Should Polaris not be in the field of view, move the telescope slowly to the right or left, the magnetic meridian being variable, or the latitude may not be exact, requiring a change in elevation, which should be varied slowly; 5 to 15 minutes generally suffice to get Polaris shortly after sunset or before sunrise with fair glasses and an ordinary atmosphere. Those who are skeptical had better rise early, get the star in the field of view and retain it until daylight. The advantages of daylight observation are too obvious to enumerate, but the method is not confined to any particular time. Having made the observation, if greater accuracy than 1′ is required, the spherical triangles, $o\,s\,p$, $o\,s'\,p$, can be solved by the method of auxiliary angles (see Chauvenet's Trig., page 180): tan φ = tan d cos H,

$$\cot z = \frac{\sin (l \pm \varphi) \cot H}{\sin \varphi} \qquad (2)$$

The signs of the second number are — when Polaris is above, + when below, Pole.

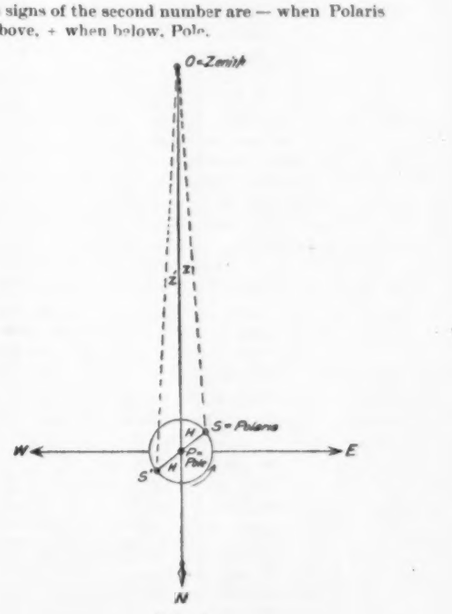


Fig. 1.

OP = Co, latitude = l; PS = Co — declination of Polaris = 1° 16′ 23″ = d; H = the hour angle SPO = S′PN. Z,Z′ = the azimuths SOP, S′OP of Polaris.

O S, O P, P S, etc., are arcs of the great circle, completing the spherical triangles OPS, OPs′. OS, OS′, OP, are vertical to the horizon

Apparent motion of Polaris opposite to the hands of the watch.

The solution of a spherical triangle is often troublesome; if the value of z in l is corrected by $\pm e \sin 2H$, where $e = \frac{1}{2}(z - z')$, when $H = 45°$, it approximates closely to the rigid solution of (2). Equation (1) then becomes

$$z = \frac{d \sin H}{\sin l} \pm e \sin 2H \quad e = \frac{d^2 \cot l}{2 \sin 1''}. \qquad (3)$$

The signs of the second member are + when above, — when below, Pole.

Values of e from Lat. 30° to 60°:

Lat. 30	e = 0′ 56
" 35	e = 0.72
" 40	e = 0.93
" 45	e = 1 20
" 50	e = 1.57
" 55	e = 2.10
" 60	e = 2.97

e represents the maximum error from using equation (1).

To make an observation of Polaris Aug. 1, 1891, at 7:30 P. M., lat. 42° N., long. 5 h. west of Greenwich:

	h.	m.	s.
R. A. of mean sun..	8	39	14
Local time of observation.	7	30	
Increase in R. A. for 7 h. 30 m. + 5 h.		2	03
	15	11	17
Mean R. A. of Polaris.	1	1s	54
	14	52	23

— 12 h. — 2 h. 52 m. 23 s = H = 43° 06′ east below Pole.

By Table C upper culmination occurs at 4 40.07 A.M. long. 90°, or 4 40 17 A. M. long. 75°. The lower culmination will occur at 4 38 19 P. M., or 1 m. 58 s.

short of 12 h. after upper culmination. Subtracting for the hour angle we have:

	h.	m.	s.
	7	30	
	4	38	19
	2	51	41
Inc. in R. A. at 10s. per hour..			28
	2	52	09

$= H = 43° 02'.$

Instead of 43° 03', a difference of 4' from using apparent instead of mean R. A., which will change the value of z a trifle over 1". Apparent R. A. and Dec. are preferable, but require an ephemeris. Table C for two to three years will give a close approximation to apparent R. A. Some of the Besselian constants for reduction to apparent position being uniform from year to year.

$$d = 1\ 16'\ 23'',\ l = 90° - 42° = 48°.$$

$$z = \frac{d \sin H}{\sin l} = 70'.25 = 1°\ 10'.25.$$

$$d \cos H = 56'.$$

Lay off 1° 10' to the east of the meridian obtained from the local variation of the needle, and elevate on the vertical arc to 42° — 56' = 41° 04'. If the observation is completed at 7:30 P. M. a correction of 11 by $-e \sin 2H$ reduces z to 1° 09'.

It is wasting time to apply the rigid solution of (2) when only the mean R. A. and Dec. are used. Polaris being below and east of the Pole its azimuth is increasing at the rate of $\frac{7d \cos H\ (19'')}{1600 \sin l}$ per minute of time. Should the observation be made a few minutes (n) before or after 7:30, the azimuth will become $1° 09' \mp 19''n$, respectively, or should the time be uncertain a similar correction can be made after observation upon a star or the sun by the first trial meridian. One correction will generally suffice for ordinary errors. A watch that is liable to be out 15 minutes should not belong to a civil engineer or a mere instrumentman.

To determine the azimuth of Polaris at 5 A. M., Sept. 10, 1891, lat. 40°, long. 90 W.:

Upper cul., Sept. 1.....	2	38	38 A. M. (by Table C).
	35	24	3m. 56s. × 9 (by Table C).
Upper cul., Sept. 10	2	03	14 A. M.
5 — (2 03 14) =	2	56	46
Increase in R. A.			30
	2	57	16 = 44° 19' = H.

$$z = \frac{\sin 44° 19' \times 76'.4}{\sin 50'} + 0'.93 \times \sin 88° 38' = 1° 10'.7.$$

Polaris being nearly 3h. past its upper culmination.

In getting time when the sun is too high for the surveyor's transit at meridian passage, the bright star Sirius can be used. No telescope would get Sirius by blind groping, but common glasses properly focused and elevated for latitude will catch the star even under a mid-day sun.

The Edison Incandescent Lamp Patent.

The most important decision in patent litigation for a long time was made by Judge WALLACE of the United States Circuit Court, on July 14, supporting the broad claim in patent No. 223,898, granted to THOS. A. EDISON in 1880, for "an improvement in electric lamps." The two chief claims in this patent were as follows:

"1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance made as described and secured to metallic wires, as set forth.

"2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass and from which receiver the air is exhausted for the purposes set forth."

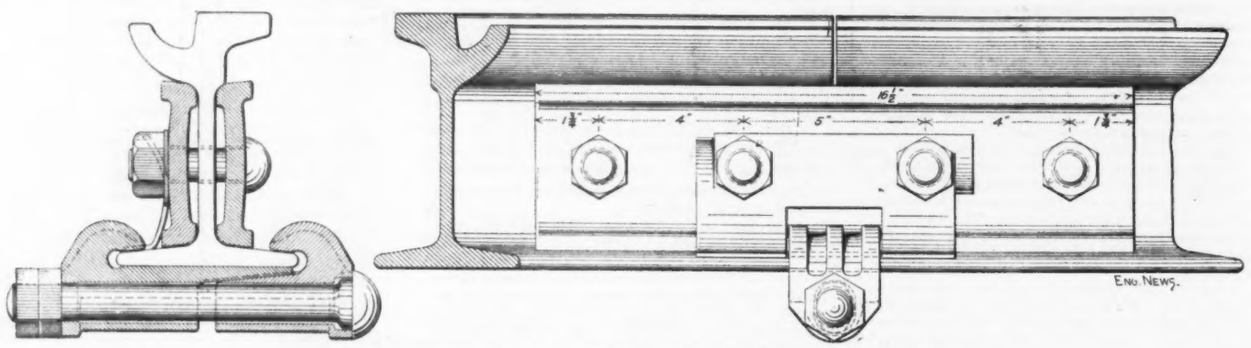
As is well known, other inventors were diligently at work endeavoring to produce a practical incandescent lamp at the time Mr. EDISON made this invention and obtained this patent, and little respect was paid to the broad claim quoted above. Rival electric companies and others began the manufacture of incandescent lamps and competition has been so brisk as to cut down profits to the lowest point. In 1885 the Edison Company began suits against some of the infringers of this patent, and the litigation has been in progress ever since.

In the suit in which a decision has just been rendered the defendant is the United States Electric Lighting Co., represented by its lessee, the Westhouse Electric Co. The decision upholding the validity of the EDISON patent was based on the second claim above quoted. We extract the following from the court's decision but would also remark that the case has been appealed and the fight is not yet over:

It was a remarkable discovery that an attenuated thread of carbon would possess the long-sought qualities of a practical burner when maintained in a perfect vacuum. The extreme fragility of such a structure was calculated to discourage experimentation with it, and it stopped to reflect when he framed his application for the patent that the filamentary burner would do its work just as well uncoiled as coiled, provided the same length and cross section were used. It is true that it is said in the general statement of the nature of the invention that the burner is so "coiled or arranged" as to offer high resistance and present a small radiating surface; but this description is satisfied by any arrangement, whether by coiling a considerable length in a small globe, on using the same length of uncoiled in a larger globe, by which sufficient total resistance is obtained from a filament of small diameter. It certainly would not involve invention to omit the coiling and elongate the globe; hence, it is manifest that the invention described is the same thing essentially whether the coiled form is used or not.

The language is satisfied, if the burner is filamentary and so arranged as to offer great resistance and slight radiation, without importing into it anything which is not of the essence of the invention. No precise limitation upon the maximum diameter of the filament can be defined from the specification or is required as an element of the claim. The specification mentions by way of illustration the threads of linen or cotton which become more attenuated after carbonization, and the carbon wire which after carbonization would be from four to five one-thousandths of an inch in diameter, while the smallest rods of carbon previously known were about a millimeter in diameter, thus having a cross-section fifty times as great as the carbon wire.

It is of little import what Mr. EDISON or his patent solicitor may have thought about the meaning of the claim during the pendency of the application for a subsequent patent, or that Mr. EDISON may have supposed a resistance as high as one hundred ohms in the burner would be required for use with the means of distribution which he expected to employ with his system of lighting. There are many adjudicated cases in which it appears that the inventor built better than he knew; where a patent has been sustained for an invention the full significance of which was not appreciated by the inventor when it was made.



THE CONTINUOUS JOINT FOR STREET RAILWAYS; McConway, Torley & Co.

The New Rail Joint of the Broadway Cable Railway.

In our issue of April 21, 1888, we illustrated and described the Continuous Rail joint of McConway, Torley & Co., of Pittsburg, Pa., as applied to a standard rail section. In the present issue we show this joint, with some improvements and modifications, as adopted by the Broadway & Seventh Avenue Railway Co., in this city, for the cable road now being built by that company.

This is the first application of this joint to street railways, to the best of our knowledge, and it is evidently well suited to this purpose, from its accessibility, economy in first cost, rigidity and general efficiency.

As will be seen by comparing the cuts, the changes made consist in the use of plain fishplates, in connection with a Johnson rail, and a positive spring nutlock plate instead of the spring washer. The washer is also dispensed with in the main button-head bolt drawing together the wedging planes. A jam nut has been substituted on this bolt with great advantage, and the action of this bolt is made positive. The castings here used are made of malleable iron, and their form and office is well shown in the cut. As will be seen there is no cutting or punching of the base of the rail, and its sole duty is to support the base of the rail rigidly; the fishplates hold the rails in line, and the springlock plate prevents the lateral movement of the malleable-iron joint, 1-16 in. being the maximum play in either direction.

The Premium Plan of Paying for Labor.

It is a striking bit of evidence of the extent to which social and economic questions are being discussed and agitated at the present day, that at the recent meeting of the American Society of Mechanical Engineers, the paper which elicited the longest and hottest discussion had nothing to do with mechanical or engineering matters, but described a novel method of solving that problem ever present before the manufacturer of to-day—the wages question.

In the report of the meeting in our issue of June 20 space, permitted only a brief explanation of the purport of the paper and of the main points brought out in the discussion which followed. As the system proposed has much to commend it on its face, and has been, moreover, in operation with marked success for some years in a few establishments, we republish the paper herewith in full, believing it to be worth a careful examination, at least, by any employers of labor who are in a position to use other than the day's work system of payment. The author of the paper, Mr. F. A. HALSEY, of Sherbrooke, P. Q., prefaced the description of the "Premium Plan" by a discussion of the other systems of payment now in use:

I. THE DAY'S WORK PLAN.

Under this method the workman is paid for and in proportion to the time spent upon his work. The objections to the plan are well known. Analyzed to their final cause, they spring from the fact that any increase of effort by the workman redounds solely to the benefit of the employer, the workman having no share in the consequent increase of production. He has consequently no inducement to exert himself and does not exert himself. Under this system, especially in a manufacturing business, matters naturally settle down to an easy-going pace, in which the workmen have little interest in their work, and the employer pays extravagantly for his product.

II. THE PIECE-WORK PLAN.

Under this plan the workman is paid for and in proportion to the amount of work done. It is a natural attempt to overcome the objections to the day's work plan. It has the appearance of being just and of being based upon correct principles. Nevertheless, extended inquiry has convinced the writer that it seldom works smoothly, and never produces the results which it should.

An employer who has become dissatisfied with the results of the day's work plan, and decides to adopt piece work, usually reasons that work which is costing in wages say one dollar per piece, could, with some extra effort, be produced on the existing scale of wages for about 80 cts.; and desiring to give the workman some inducement, offers him 90 cts. per piece, thereby dividing the expected saving with him. The trouble begins at once. The workman does not believe that he can "make wages" at the rate offered, and objects. He is, however, finally induced or compelled to try it, and immediately proceeds to astonish himself and all others by increasing his output far beyond the expected 25%. His earnings increase with startling rapidity, *but the cost of the work remains where set, at* 90 *cts. per piece*, and the employer soon finds that instead of a substantially equal division of the savings, he is getting but little, and the workman practically all of it. He accordingly proceeds to cut the piece price, and the fatal defect of the system appears. This cut is in appearance and in fact an announcement to the workman that his earnings will not be allowed to exceed a certain amount and that should he push them above that amount he will be met with another cut. Cutting the piece price is simply killing the goose which lays the golden egg. Nevertheless, the goose must be killed. Without it the employer will continue to pay extravagantly for his work; with it he will stifle the rising ambition of his men.

The difficulties of the day's-work and piece-work plans are thus seen to be the exact antithesis of one another. Analyzed to their final cause, the difficulties with the piece-work plan spring from the fact that the piece price once set, any increase of effort by the workman redounds to *his own* benefit alone—the employer having no share in the consequent saving of time. To obtain a share he cuts the piece price, with the consequences stated. Under this system matters gradually settle down as before to an easy-going pace in which the workmen approach the limit of wages as nearly as they consider prudent. Their earnings are somewhat more and the cost of the work is somewhat less than under the day's-work plan, but there is no more spirit of progress than under the older method. The employer is constantly on the lookout for a chance to cut the piece prices, that being his only method of reducing cost; and the men are constantly on the lookout to defeat the employer's well-understood plan, well knowing, as they do, that any one who is so unwise or so unfortunate as to do an increased amount of work will be in effect punished for it by having his piece price cut and himself thereby compelled to work harder in the future for the old amount of income. The system makes the interests of the employer and employee antagonistic, and hence of concerted effort toward a progressive reduction of cost there is none. This I believe to be the usual and natural history of the piece-work plan. I know it to represent the situation in some of the foremost machine shops of the country. An additional objection to the plan grows out of the fact that it requires a knowledge and record of the cost of each piece of a complicated machine, and oftentimes of each operation on each piece. This limits its range of application to products which are produced in considerable quantities.

III. THE PROFIT-SHARING PLAN.

This plan was originally devised in the effort to avoid the objections to the two former plans. Under it, in addition to regular wages, the employees are offered a certain percentage of the final profits of the business. It thus divides the savings due to increased production between employer and employee, and at first sight appears to meet the difficulties of the plans thus far discussed; but, nevertheless, on analysis, will be found to be as defective as they, both in principle and application. The leading objections to the plan are the following:

First. The workmen are given a share in what they do not earn. Increased profits may arise from more systematic shop management, decreased expenses of the sales department, or many other causes with which the workmen have nothing to do. Anything given them from such sources becomes simply a gift, the result of which is wholly pernicious; in fact, the entire system savors of patronage and paternalism.

Second. The workmen share regardless of individual deserts. An active, energetic workman cannot have the same incentive to increased exertion under a system which divides the results of his efforts among a dozen lazy fellows at his side that he would have under one in which his earnings depend on himself alone; on the other hand, a lazy workman would naturally consider it much easier to take his portion of the earnings of his fellows than to exert himself and then divide the results with all the others of the force.

Third. The promised rewards are remote. The incentive cannot be as great under a system which computes and divides the savings once or twice a year as under one which pays out the extra earnings week by week.

Fourth. The plan makes no provision for bad years. We hear much of profit sharing, but nothing of loss sharing. And yet the workman cannot expect to share the profits while others assume the losses; and, *per contra*, those who assume the risk of loss cannot be expected to share the profits with those who have nothing at stake.

Fifth. The workmen have no means of knowing if the agreement is carried out. With their exaggerated ideas of the profits of business, the results must be in many cases disappointingly small, and they will doubt the honesty of the division. What is to be done in such a case? Invite the workmen to appoint a committee to examine the books, and report? Most employers will demur at this, and yet without it the employees can have no assurance of good faith; and were it done, what good could result? How many workmen's committees are there who are sufficiently versed in modern accounts to form any idea of the proceeds of the year's business from an examination of the books? In this light the profit-sharing plan is seen to be an agreement between two parties, the first of whom has every temptation and opportunity to cheat the second, while the second has no means of knowing if he has been cheated, and no redress in any case. In the present state of human nature this cannot be expected to be satisfactory to the second party. The fact that the plan has worked with apparent success in some instances, and for considerable periods of time, proves nothing. The most disastrous boiler explosions and bridge failures have been preceded by long periods of apparent safety. Even the Conemaugh dam held water for many years. It is a truism that the most rickety and unsafe devices often serve their purpose for long periods. At the beginning the workmen look on the amount received at the annual division as a bonus, and anything is better than nothing; but later on they will look on it as theirs by right of having earned it, and the above situation is certain to arise. The fact is that the profit-sharing plan is wrong in principle, and cannot be in any large sense a solution of the wages problem.

IV. THE PREMIUM PLAN.

Taking up now the subject proper of this paper, it aims at a division of the savings due to increased production between the employer and employee, but by a direct method instead of by the circuitous one of the profit-sharing plan. The plan assumes two slightly different forms, according to the nature of the work; one form being suited to work produced in such quantities as to be reducible to a strictly manufacturing basis, and the other form to the more limited production of average practice. In both forms the essential principle is the same, as follows: The time required to do a given piece of work is determined from previous experience, and the workman, in addition to his usual daily wages, is offered a premium for every hour by which he reduces that time on future work, the amount of the premium being less than his rate of wages. Making the hourly premium less than the hourly wages is the foundation stone on which rest all the merits of the system, since by it if an hour is saved on a given product the cost of the work is less and the earnings of the workman are greater than if the hour is not saved, the workman being in effect paid for saving time. Assume a case in detail: Under the old plan a piece of work requires 10 hours for its production, and the wages paid is 30 cts. per hour. Under the new plan a premium of 15 cts. is offered to the workman for each hour which he saves over the 10 previously required. If the time be reduced successively to 5 hours the results will be as follows:

Time consumed. Hours.	Wages per piece. $	Premium. $	Total cost of work = col. 2 + col. 3. $	Workman's earnings per hour = col. 4 ÷ col. 1. $
10	3.00	0	3.00	.30
9	2.70	.15	2.85	.317
8	2.40	.30	2.70	.333
7	2.10	.45	2.55	.364
6	1.80	.60	2.40	.40
5	1.50	.75	2.25	.45

This table illustrates the manner in which the cost of the work diminishes and the workman's earnings increase together until, to cite the extreme case of the last line, if the output be doubled, the wages paid per piece will be reduced 25%, but the workman's earnings per hour will be increased 50%. Were the premium less than 15 cts. per hour, the reduction in cost for each hour saved would be greater and the workman's earnings less. On the other hand, the workman would have a smaller incentive, and the time would not be reduced so much. The output would be less, and the net result might be worse for both employer and employee. This raises the inevitable question: What should be the rate of the premium? Nothing but good sense and judgment can decide in any case. In certain classes of work an increase of production is accompanied with a proportionate increase of muscular exertion; and if the work is already laborious, a liberal premium will be required to produce results. In other classes of work increased production requires only increased attention to speeds and feeds with an increase of manual dexterity and an avoidance of lost time. In such cases a more moderate premium will suffice. Any attempt, however, on the part of the employer to be greedy and squeeze the lemon too dry will defeat its own object, since if a trifling premium be offered, the workman will not consider it worth while to exert himself for so small a reward, and the expected increase of output will not take place. On the other hand, if the premium offered be too high, the employer will simply pay more than necessary for his work, though less than he has been paying. If the rate of premium is decided upon judiciously, it may and should be made permanent. No cutting down of the rate should ever be made unless, indeed, improved processes destroy the significance of the first time base. Every increase of earnings is necessarily accompanied by a corresponding decrease of cost, and if the premium be such as to give these a satisfactory relation, the workman may be assured that there will be no limit set to his earnings; that the greater they are the more satisfactory they will be to the employer. The importance of this can not be too strongly insisted upon. If the premium be cut the workmen will rightly understand it to mean as under the piece-work plan, that their earnings are not to be permitted to pass a certain limit, and that too much exertion is unsafe. The very purpose of the plan is to avoid this by so dividing the savings between employer and employee as to remove the necessity for cutting the rate, and hence enable the workman's earnings to be limited only by his own ability and activity. The baneful feature of the piece-work plan is thus completely obviated, and instead of periodical cuts with their resulting ill-feeling, the premiums lead the workman to greater and greater effort, resulting in a constant increase of output, decrease of cost, and increase of earnings.

The broad-minded employer will not fail to recognize that his own gain from the system comes largely from the increased production from a given plant, since not only does the system reduce the wages cost of the piece of work in hand, but in so doing it increases the capacity of the plant for other work to follow. The advantages from this source are so great as to render unnecessary any refined hair-splitting as to the rate of the premium.

Such is the premium plan, and the writer confidently predicts that the more it is studied the more perfect will appear its adaptation to the requirements of industrial enterprise and human nature. Surely a system which increases output decreases cost and increases workman's earnings simultaneously, without friction, and by the silent force of its appeal to every man's desire for a larger income, is worthy of attention. In addition to the commanding features noted, it has other features of lesser note. The transition to it from the day's work plan is very easy and natural. It does not involve a reorganization of the system of bookkeeping, but only an addition, and a small one, to the existing system. No opposition to it, organized or otherwise, is possible, since there is nothing compulsory about it, and nothing tangible to oppose. It is simply an offer to gratify one of the strongest passions of human nature, and the difficulty often found in introducing piece work cannot occur with this.

In carrying out the plan in connection with work which has been reduced to a manufacturing basis, the writer finds the following form of time ticket convenient:

TIME TICKET.

Name of Part..... *No. of Pieces*.....

Operation..... *Workman*.....

Date.	HOURS. 7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	1	1½	2	2½	3	3½	4	4½	5	5½	6 Over time

Machine set by ..... *Time*..... *hours.*

This ticket is issued by the foreman, the blanks at the top being filled up by him. If desired as a check he punches a hole on the line, indicating the hour when the work is given out, repeating the same when the work and ticket are returned. The record of the time is kept by drawing a line between the various hour marks, an operation which the most illiterate can perform. The ticket provides for several days' work, and is not returned until the work is completed, when it contains the record of the entire job.* On the back of the ticket is printed the following:

According to previous experience this work should require .. hours. If completed in less time than that a premium of....cents will be paid for each hour saved.

When the ticket is returned, a comparison of the back with the front shows the premium earned. This is entered opposite the workman's name, in a book kept for the purpose, which is a companion to the usual time book or pay roll. On pay day the accrued premiums are paid to each workman along with the regular wages. The cost book is written up from the ticket in the usual way, except that as the ticket usually contains the record of several days' work, the labor of keeping the cost book is much abridged.

On work which, while produced as a regular product, is still not produced in sufficient quantity to justify recording the cost of each part, the premium offer is made to the group of men who carry out the work. The proposition is made as a posted notice, or otherwise in the following form:

According to previous experience this work should require....hours. If completed in less time than that a premium of....cents per hour saved will be divided among those working on the machine, division to be in proportion to time spent on the work.

In this form the system loses the advantage of dealing directly with the individual, and the second objection to the profit-sharing plan is introduced, though in a modified degree, as a small group of men is dealt with instead of the entire force. The remaining objections to the profit-sharing plan are not introduced, and on such work the plan proposed is distinctly superior, though lacking theoretical perfection. The piece-work plan does not apply to work of this kind, and hence there can be no comparison between it and the plan under discussion.

On contract work undertaken for the first time the method is the same, except that the premium is based on the *estimated* time for the execution of the work. The system is thus applicable to all classes of machine shop work except "jobbing" or work done by the hour, and there is no very vociferous demand from the shops for a method of reducing the time on that class of work.

The writer believes that, judiciously administered, the plan proposed will produce a larger output and cheaper work, and at the same time pay higher wages than any other whatsoever.

Legal Decisions of Interest to Engineers.

Acceptance of Work on Engineers' Estimate.—When a railroad construction contract provides that the grading shall be done under the supervision of the chief engineer and his assistant, whose estimate of quantities is to be final and conclusive between the parties, and that the contractor shall be paid monthly for work done upon certificate of the engineer, the company is not entitled to have the work re-estimated by another engineer after payment has been made, unless it can show fraud or collusion. Mere errors or inaccuracies resulting from incompetence or negligence on the part of the engineer are not enough to warrant the company in going behind the certificate. (Chicago, S. F. & C Ry. Co. v. Price, Sup. Ct. of the United States, 11 Sup. Ct. Rep., 290.)

Right of Massachusetts Towns to Maintain Electric Light Plants.—The Legislature of Massachusetts can, by statute, confer upon towns authority to construct and maintain works for the manufacture and distribution of electricity to be used by the towns and the inhabitants for illuminating purposes, but such authority is not within any of the customary powers which towns, from very early times, have exercised, and must be derived, if it exists, from the statutes relating to towns. The mere authority to maintain street lamps does not imply to the power to erect plants for the manufacture of the light, any more than the power to maintain a public library confers upon a municipality to the right to operate a paper mill and publishing establishment. The right to purchase and operate an electric plant must be specifically conferred, and the Massachusetts statutes do not contain such a grant. (Spaulding v. Peabody, Sup. Jud. Ct. of Mass., 26 N. E. Rep 422.)

* This rule holds, even when the job after being partly finished is interrupted by something more pressing. In such a case the ticket is taken up by the foreman in order to insure that the entries have been made for the completed work. He issues the ticket again when the work is resumed, and when all is completed this ticket goes to the office, where a single entry in the cost book records what, under the usual method, might require a half dozen or even more entries.

The Sandstone Industry.

During the year 1889 71,71,054 cu. ft. of sandstone were produced in the United States, valued at $10,816,057. Census Bulletin No. 73, devoted to this industry, says that the total capital invested is $17,776,467, and that $6,257,580 were paid out in wages, in 1889. to near y 17,000 workmen.

Ohio holds the first rank as a producing state, with an output for 1889 valued at $3,046,656. Pennsylvania comes next, with $1,609.159, and Colorado third, with $1,:24.098. Connecticut, New York, Massachusetts and New Jersey follow in the order given, with outputs ranging in value from $920,061 to $567,300. The total production of sandstone in 1880, or at the last census, was valued at $4,780,391. The gain in the last 10 years was therefore 126.26%. Ohio and Pennsylvania supply much of the stone used for building purposes; and these states, together with New Jersey, Colorado and Connecticut, furnish about one-half of all the sandstone used for this purpose. New York and Colorado together supply nearly 5,000,000 cu. ft. for street work; and Pennsylvania has the lead, with 5,000,000 cu. ft., in furnishing sandstone for bridges, dams and general railroad work.

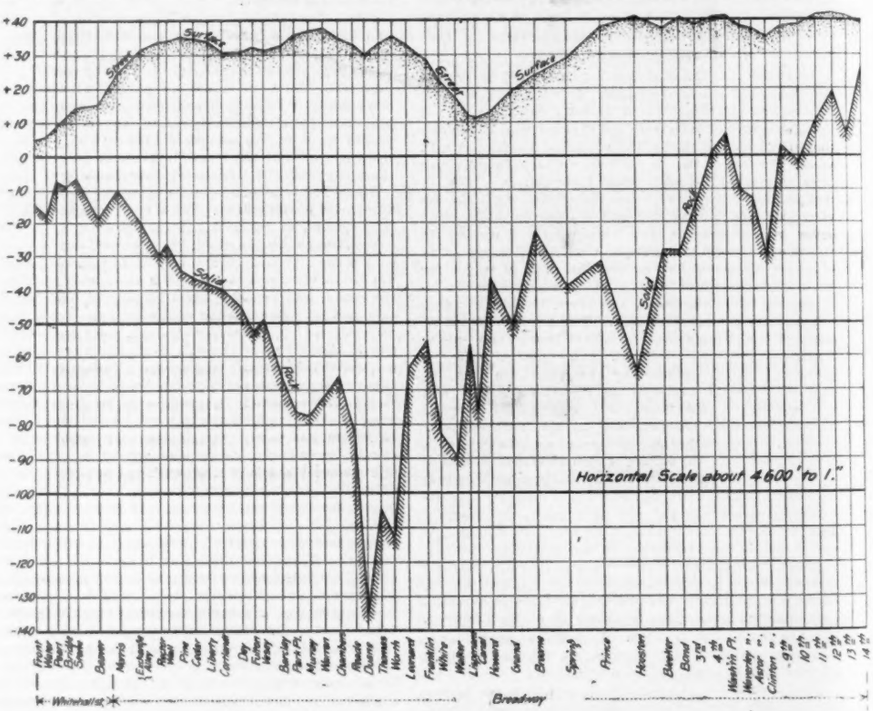
Borings for Rock Along Broadway, New York.

The Broadway borings, made by Messrs. W. E. Worthen and W. B. Parsons, engineers for the New York Subway Commission, are completed, with the following results:

	Feet to bed rock.		Feet to bed rock.
Whitehall St.:			
Front St.	20. 0	Walker	107.20
Water	23 00	Lispenard	68.25
Pearl	16.90	Canal	87.65
Bridge	20. 0	Howard	50 00
Stone	21.00	Grand	70 80
Beaver	34.00	Broome	47.75
Broadway:		Spring	7 .10
		Prince	70.00
Morris	3 .25	Houston	105.20
Exchange Alley	51.50	Bleecker	65.15
Rector	63.10	Bond	68.85
Wall	60.10	Third	53 00
Pine	70.00	Fourth	40.10
Cedar	70.75	Washington Place	34.55
Liberty	70.90	Waverley Place	48.85
Cortlandt	70.30	Astor Place	49.75
Dey	73 85	Clin on Place	65.25
Fulton	83.25	Ninth	35.25
Vesey	8 .50	Tenth	40.33
Barclay	101.15	Eleventh	31.15
Park Place	112.50	Twelfth	22.60
Murray	113 50	Thirteenth	34.00
Warren	109 20	Fourteenth	13 25
Chambers	100.75	Seventeenth	10.15
Reade	116.00	Twenty-first	17.00
Duane	163.50	Twenty-third	21 50
Thomas	138.50	Twenty-fifth	24.00
Worth	147.50	Twenty-seventh	19 20
Leonard	96 55	Thirtieth	15.00
Franklin	83 45	Thirty-third	4.00
White	105.50		

The general formation of the soil is favorable for tunneling operating with a shield. From the Battery to Chambers St. the sand is fine, as a rule; north of Chambers St. it is coarse and gritty, with gravel. The record at Canal St. is so much more favorable than was expected that the borings are to be made again, but no change is expected. Deep depressions in the rock surface are noted at Duane, at White and Walker Sts. and at Houston St.

We have prepared a profile of these borings, made from the above list and street level data in this office, and here given. These borings pretty effectually settle the deep rock-tunnel scheme which we favored at one time on general principles; for the reason that to pass under the deeper depressions in the rock surface would cost too much both in removing material and in operating the tunnel with elevators. And it would be very undesirable in tunneling through sand with a shield to encounter rock or heavy bowlders in the bottom of any part of the tunnel. If a tunnel is to be built under Broadway it will evidently have to be a compromise between one near the street surface at the Battery



PROFILE OF STREET SURFACE AND UNDERLYING ROCK FROM FRONT ST TO FOURTEENTH ST., AS DETERMINED BY BORINGS MADE BY THE RAPID TRANSIT COMMISSION'S ENGINEERS.

end and a deep tunnel in sand about Canal St., gradually rising again to near the surface about Fourteenth St.

The Edison Electric Drill.

In our issue of May 16, 1891, the Edison electric drill was fully described and the general principle of its operation illustrated. The cut given herewith shows the drill fitted to a column for tunnel work, the previous cut showing it on a tripod.

The engineer of the Last Chance mine at Wardner, Idaho, writes to the Edison Electric Co., of New York, that two air-drills run for 24 hours required 5 cords of wood to operate them; while 4 electric percussion drills in the same time required the burning of only 1½ cords of wood to generate the power. The engineer also states that each electric drill did more work than the air-drill, in his mine, and that as a consequence they have replaced the air-drills.

EDISON ELECTRIC DRILL.

No exact figures are given for the difference in work, but it is stated that the air-plant was situated 1,000 ft. higher up the mountain than the electric plant, and the fuel had to be carried this extra distance and thus added still further to the cost of operating the air-drill.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Adriondack & St. Lawrence.—A press dispatch says:

The Adriondack & St. Lawrence will be opened and trains run from Malone, N. Y., as far as Saranac Junction and Paul Smith's on July 15. On July 30 trains will proceed to Saranac village for Hotel Ampersand and will make stage connections over a plank road for Lake Placid, a distance of 8 miles. On Aug. 1 trains will run to Meacham Lake and to Loon Lake station, the terminus of the road, which is 5 miles from Loon Lake House. Stage connections are made at all points. The railroad at present under construction from Herkimer to Malone will be opened in 1892.

The work is being found to be considerably more difficult than was expected, owing to the rocky nature of the country and the large number of bowlders found in places.

Wild River Lumber Co.—The contract for building the 10-mile railway from Gilead, Me., on the Grand Trunk Ry., to the timber lands of this company has been let to A. M. Gallup, of Swanton, Vt.

Philadelphia & Reading.—Work is being pushed night and day on the Port Reading R. R., and it is expected that the line will be in operation by Jan. 1.—The Tuckahoe & Cape May R. R. has been consolidated with the Philadelphia & Seashore R. R., thus creating a continuous line from Camden, N. J., to Cape May City. Work is progressing very fast on the Philadelphia & Seashore, and the road has been completed from Winslow Junction, on the Philadelphia & Reading's Atlantic City line, to Sea Isle City, N. J., and trains are now running between Camden and Sea Isle City. Grading has been completed on the Tuckahoe & Cape May, and crossties are laid. It is expected that before the summer has passed trains will be running over the entire road.

Baltimore & Ohio.—Mr. John B. McDonald, of Ryan & McDonald, contractors for the Akron, Chicago & Junction R. R., who has recently returned from an inspection of the work, is quoted as saying:

The road is completed and ballasted from Warwick to Akron Junction, 60 miles. It only remains to complete some sidings and to build depots and arrange depot grounds before this section will be turned over to the Baltimore & Ohio Co., for whom constructed. The transfer is expected to be made between July 10 and 15, when trains will be run regularly over the completed section. Work on the remaining section of the line is being rapidly pushed, as is also the work on the Worcester & Lodi R. R. Rails are now being laid on the last-named road, which will be in operation in 90 days. This is a line 20 miles in length between the points named, and will form one of the western connections of the Baltimore & Ohio. Ryan & McDonald are the contractors.

Richmond & Chesapeake.—At the annual meeting recently held the following officers were elected: President, N. E. Reed, New York; Vice President, C. E. Belvin, Richmond; Directors, H. R. Baltzer, E. V. Baltzer and Ellis R. Southworth, of New York, and C. E. Belvin and C. O. Swann, of Richmond. Col. E. J. Brooks, the contractor, was present, and it was decided to commence work at once, putting the Eighth St. Tunnel, so far as it has progressed, in order for pushing it to completion as soon as the city of Richmond shall extend the franchise for such purpose. The contractor has now, it is stated, funds in hand for that purpose. The company has issued $4,500,000 in bonds to complete the tunnel and its road to the Potomac River, and it is said that satisfactory negotiations are in progress for placing them.

Projects and Surveys.

Detroit & St. Clair River.—It is stated that the contract for building this railway from Detroit, Mich., to St. Clair, Mich., has been let to E. G. Green, New York City, and that work will begin at once. W. D. Jackson, Detroit, is Chief Engineer.

Skowhegan & Norridgewock.—This company has completed its organization by electing the following officers: President, R. B. Shepard; Clerk, J. O. Smith, and Treasurer, A. H. Weston. Steps are being taken to put the work under contract.

Alloway & Quinton.—Chartered in New Jersey to build a railway from Alloway Station, on the West Jersey R. R., to Quinton, N. J. Among the incorporators are: A. O. Drayton, Camden, N. J., and M. P. Grey, Salem, N. J.

Brookline & Pepperell.—Franklin Worcester, of Hollis, N. H., President, writes as follows:

The surveys have been partly completed for this railway, which is to run from Brookline, N. H., via Hollis, N. H., and Pepperell, Mass., to Groton, Mass., 13 miles. Nearly all the right of way has been secured. The work will be easy. Contracts will not be let until the charter is secured in Massachusetts, which will probably be about Aug. 15. Augustus W. Locke, of North Adams, Mass., is Chief Engineer.

Westerly & Jewett City.—A large part of the capital stock of this company has been subscribed for and construction will probably begin soon. The road is to run from Westerly, R. I., to Jewett City, Conn., 25 miles. Thos. Chappelle, Rutland, Vt., is Chief Engineer.

SOUTHERN.—Existing Roads.

Roanoke & Southern.—Work is being pushed rapidly on the line from Martinsville to Roanoke, Va. About four-fifths of the grading has been finished, and tracklaying is in progress at both ends.

Norfolk & Western.—Work will be begun soon upon the belt line at Roanoke, Va. The line will be 9¼ miles long, and will run from Vinton around the south part of the city to West End Furnace, where it connects with the main line.

Illinois Central.—The people of Natchez, Miss., are endeavoring to secure the construction of a branch from Brookhaven, Miss., or some other point on the main line to that place.

Tifton & Northeastern.—This railway is now open for general business from Tifton to Irwinville, Ga. Work is in progress on the extension toward Abbeville, Ga. President, H. H. Tift, Tifton, Ga.

Dover & Statesboro.—A correspondent writes us that this road will run from Statesboro to Jessup, Ga. A. D. Killebrew, Chief Engineer, Statesboro, Ga., has completed the survey from Statesboro to the Macon & Atlantic R. R.

Middle Georgia & Atlantic.—The Seaboard Co. has begun work at Hutchinson Island, near Savannah, Ga., upon the terminals of this road. Chief Engineer Arthur Pew, Savannah, Ga., will soon begin the location of the line from Savannah, northwest. Several routes will be surveyed and the most favorable adopted. It is intended to make the line as nearly an air line as possible. Work will begin as soon as sufficient of the line has been located. The line from Machen to Eatonton, Ga., is completed and the grading has been completed between Machen and Covington and tracklaying will soon begin.

Fincastle & Troutville.—Three miles of the grading have been completed between Fincastle and Troutville, Va., 6¾ miles, and work is well advanced upon the remaining distance. It is expected to have the roadbed ready for the track in about two months. The contract for crossties and tracklaying has been let to Geo. A. Houston & Co.

Gainesville, Rocky Point & Micanopy.—James M. Graham, of Gainesville, Fla., Vice President, writes us as follows:

This road is projected to run from Gainesville, Fla., via Rocky Point, to Micanopy, Fla., 12 miles, crossing Alachua Lake. The surveys have been completed and all of the right of way secured. Except for the 2 miles of trestle across the lake the work will be light. The route is through a fine orange and vegetable growing section, and the principal business of the road will be the transportation of the products of the farms and orange groves. The road is backed by the Savannah, Florida & Western and the Florida Central & Peninsular railways, whose lines it will connect and who will furnish the rails for laying the track. N. A. Collison has the contract, and will complete the road by August 1. J. W. Carter is President and P. F. Jenkins is Chief Engineer, both of Gainesville, Fla.

Substantially the same information has been sent us by H. F. Dutton, of Gainesville, Fla.

Projects and Surveys.

Mississippi Central Valley.—The contract has been let for building this 6¼-mile railway from Rosedale to Bogue Phalia, Miss. Chas. Scott, Rosedale, Miss., President.

Atlanta, Southern & Western.—A bill has been introduced into the Georgia State Logislature to charter a rail way company by this name.

Chesterfield & Kershaw.—J. W. McKay, of Cheraw, S. C., President, writes that the surveys have been completed for this railway from Cheraw to Camden, S. C., 60 miles, but that no definite action has been taken toward its construction. Local subscriptionsto the amount of $50,000 have been obtained.

Arcadia, Gulf Coast & Lakeland.—K. B. Harvey, Punta Gorda, Fla., Chief Engineer, writes us that the surveys for this railway will be completed about Aug. 1. The line will be 200 miles long, and will run from Lake, land to Boca Grande, Fla. The right of way has been secured and considerable local aid obtained. The work will be easy and there will be but a small amount of bridging.

NORTHWEST.—Existing Roads.

Duluth & Iron Range.—The surveys of the proposed extension of this Minnesota railway to the International line have been discontinued.

Duluth, Red Wing & Southern.—The preliminary survey from Duluth, Minn., south is making slow progress. It is stated that the present plans of the company are to build a line south from the head of the lake to a connection with the Eastern Minnesota R. R., and to construct a short section at the Soo Crossing during the present year.

Duluth & Winnipeg.—The grading is nearly completed on the line from Cloquet to Duluth, Minn., and the bridge-work is well advanced. It is expected to begin tracklaying in about a month.

Duluth Transfer.—This company has filed a mortgage for $2,000,000 with the Metropolitan Trust Co., of New York City, the proceeds to be used in building its proposed terminal facilities at Duluth.

Projects and Surveys

Eau Claire, Mississippi River & Lake Superior.—C. E. Bussell, of Eau Claire, Wis., writes us that there is but little prospect of this road being constructed unless outside capital is secured. The road is projected to run from Chippewa Falls, Wis., south to Winona, Minn., and north to Ashland, Wis. About 90 miles of the line have been surveyed. R. F. Wilson, of Eau Claire, Wis., is President.

Ontario & Rainy River.—Zeph. Malhiot, ofSault Ste. Marie, Ont., Chief Engineer, writes as follows:

This road is to run from Port Arthur, Ont., along the Kaministiqua and White Fish r vers to White Fish Lake, thence via Iron Lake and along the Antic-Okan River to Sturgeon Falls, Fort Francis and the mouth of Rainy River, and thence to Winnipeg, Man. The first 50 miles of the line from Port Arthur, Ont., will be formed by the Port Arthur, Duluth & Western R. R., over which this company has trackage rights. About 100 miles of the preliminary survey have been completed, and about 300 miles more have been thoroughly explored. The work will be light; maximum grade 1% and maximum curve 6°. The principal business of the road will be in ore, timber, farm produce and general merchandise. D. F. Burke is President.

Phillips & Kennan.—A company is to be chartered in Wisconsin to build a railway from Phillips to Kennan, Wis., about 18 miles.

SOUTHWEST.—Existing Roads.

Hearne & Brazos Valley.—H. L. Lewis, of Hearne, Tex., General Superintendent, writes us that eight miles of the grading has been completed on this Texas railway. The route is through an agricultural section and the planters are building the line. It is intended to build only 10 miles of the road at present. Tracklaying will begin about Aug. 15, and it is expected to have the road in operation one month later. T. C. Westbrook is President and W. S. Williams is Chief Engineer.

Denison, Bonham & New Orleans.—A report is in circulation that work will soon be resumed on this partly graded railway from Denison to Bonham, Tex.

Projects and Surveys.

Paris, Choctaw & Little Rock.—C. G. Woodbridge, of Paris, Tex., is reported as saying that this railway would be constructed this fall.

Texas, Louisiana & Western.—The contract for building 10 miles of this road from Conroe, Tex., to a point in Liberty County, Tex., has been let to T. C. Clay.

Kansas City, Bentonville & Southeastern.—Work has been commenced at Bentonville, Ark., upon this proposed railway from Bentonville to Pineville, Mo. Watson & Schneider, of Cameron, Mo., are the contractors.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—Greenough & Massey, of Missoula, Mont., have the contract for filling the trestles on the Crescent Division between Pasco and Cascade Junction.

Great Northern.—Contracts for 50 miles of the Pacific extension along the Pend d'Oreille River have been let to the San Francisco Bridge Co. Work is to be begun at once. Tracklaying is being rapidly pushed on the Seattle & Montana R. R. Tracklaying is now completed from Seattle to the Steilaguamish River, and will soon begin from Fairhaven, Wash.

Salt Lake & Bountiful.—The surveys have been completed for this Utah railway and construction will begin at once.

Burlington & Missouri River.—About 300 teams are at work on the extension from Merino to Buffalo, Wyo. It is expected to have the line completed to the Belle Fourche River by Aug. 1.

Projects and Surveys.

The Dalles, Dufur & Silkstone.—R. H Norton, of The Dalles, Ore., Chief Engineer, writes as follows:

This road is projected to run from The Dalles, along Five, Eight, Ten and Fifteen Mile creeks to Dufur, thence through the Cascade Mts. to Tygh Valley and thence to the Silkstone mines, about 200 miles. About 147 miles have been located and surveys are yet in progress. The work will be light, with grades varying from 20 ft. to 80 ft. per mile and very light curves. There will be one bridge across Des Chutes River and a tunnel 2,200 ft. long. The right of way has been secured and contracts for construction will be let during August. The principal business of the road will be in wheat, lumber, wool and coal. The company was chartered June 13, 1891. Geo. A. Liebe, The Dalles, Ore., President.

Snohomish, Skyhomish & Spokane.—Arrangements are completed for constructing this railway from Snohomish to Port Gardner, Wash., 10 miles.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable at the following places: Lockport, N. Y.; address J. M. Fitzgerald, of Rochester; Whatcom, Wash., address H. E. Waity; Indianapolis, Ind.; address Board of Public Works; Norfolk, Va.; address the Norfolk & Atlantic Terminal Co. and M. W. Mason; Niles, O.; address A. B. De Camp Bartlett, Mo.; Clayton, Mo.; Mineral Ridge, O; Meadville, O. Windsor, Ont.; address W. C. Turner, Superintendent Sandwich, Windsor & Amherstburg Electric R. R.; Kansas City, Mo.; address the Missouri, Kansas & Texas Trust Co.; Northport, Me.; Seattle, Wash.; address the Rainier Ave. Electric Ry. Co.

Pelham, N. Y.—It is reported that a line will be built by the Westchester R. R. Co., connecting the New York, New Haven & Hartford R. R. with Travers Island.

Jersey City, N. J.—President Thurston, of the Jersey & Bergen R. R. Co., is reported to be in conference with the Rapid Transit Co. of Newark, with a view to establishing a line between Newark and Jersey City.

Salem, Va.—The Salem Street Ry. Co., of which Col. A. M. Bowman is President, has received a franchise to construct and operate a line here. The franchise stipulates that the work shall commence within 3 months and be completed within 18 months. The company is to pay to the city 2% of its gross receipts, and the fare shall not exceed 5 cts.

Asheville, N. C.—President Frank Reynolds, of the Asheville & Rutherfordton Electric Ry. Co., reports that contracts for grading will be let immediately.

Mobile, Ala.—The Mobile Street Ry. Co. has accepted the franchise allowing the substitution of electricity for mules, and the change will, it is said, be completed by November.

Anderson, Ind.—The Anderson Street Ry. is said to have been bought by local parties, who will extend it and introduce electricity.

Martinsville, Ind.—The City Council granted a 30-years' franchise to the Martinsville Rapid Transit Co. on July 8 for an electric line.

Alton, Ill.—A bonus of $6,000 is said to be offered by citizens of this place for a line to North Alton, 2½ miles distant.

Saginaw, Mich.—The Union Electric St Ry. Co. has, it is said, appropriated $100,000 for the extension of its lines. It will build a new power station and have 20 new cars.

Marquette City, Mich.—The Marquette City & Presque Isle Ry. Co. has recently completed 3 miles of track and will operate the same on the Thomson-Houston system, being the first road using that machinery in that state.

Detroit, Mich.—The Grand River Ry. Co. has petitioned the Common Council for permission to equip its lines with electric machinery.

Sioux City, Ia.—The Sioux City & Morningside Ry. Co., incorporated May 4, will build a 3-mile line. Contracts for grading, rails and track have been let and the road will probably be opened in October. The President is J. M. Jackson.

Horse Railways.—New lines or extensions are reported as probable at Florence, Ala., address B. R. Stoughton; Tyler, Tex., address the Tyler Star Lumber Co.; Charleston, W. Va., address the Charleston Street Ry. Co.; Ocala, Fla., address D. A. Miller.

Dummy Railway.—*Waco, Tex.*—The Waco Dummy Ry. Co., operating a 4½-mile line, is reported to have issued $50,000 of bond for better equipment and track.

Elevated Railways.—*Chicago, Ill.*—The stockholders of the Lake St. Elevated R. R. Co. have voted to increase the capital stock of the company from $3,000,000 to $5,000,000.

Milwaukee, Wis.—A new company has been incorporated under the name of the Interstate Electric Ry. Co., which proposes to build an elevated electric line from this city to Chicago, a distance of 85 miles. The capital stock is placed at $10,000,000, and among the directors are G. T. Cox, of Portage, Wis.; F. A. Delaglise, of Antigo, Wis.; Isaac Edwards, of St. Paul, Minn.; J. W. Dickinson, of Milwaukee, and C. F. Goodrich, of Chicago. Double tracks are to be laid along the whole length of the line, and the current will be obtained from three power stations, according to Chicago exchanges.

New Companies.—Applegate Electric Conduit Ry. Co., Chicago, Ill.; capital stock, $2,500,000; incorporators, W. H. Applegate, W. H. H. Thomas, S. H. O. Homewood. South Harvey & Harvey Electric Dummy R. R. Co., Chicago, Ill.; capital stock, $25,000; incorporators, W. C. McClintock, J. A. Hartmann, F. A. Bangs. Blue Island R. R. Co., Blue Island, Ill.; capital stock, $25,000; incorporators, J. B. Crocker, E. M. Warren, W. J. Hoether and others. Broad Ripple Ry. Co., Indianapolis, Ind.; capital stock, $50,000; incorporators, T. O. Morris, of Indianapolis, P. F. Swing, of Batavia, O., J. E. Mooney, of Louisville, and others. Norwood Park & Maine Electric Ry. Co., Chicago, Ill.; capital stock, $250,000; incorporators, F. J. Short, M. E. Cole, R. O. Dunning. Lockport & Olcott Beach Electric R. R. Co., Lockport, N. Y.; capital stock, $120,000; Secretary, O. F. Tiffany, of Rochester. Metropolitan Ry. Co., Denver, Colo.; capital stock $1,000,000; Morgan Park & Pullman Electric Street Ry. Co., Chicago, Ill.; capital stock, $250,000. Amador Electric Railway and Light Co., Sutter City, Cal.; capital stock, $500,000; incorporators, E. C. Voorheis, R. C. Downs, S. N. Knight and others. Grand Park Electric Ry. Co., Atlanta, Ga., capital stock, $160,000, incorporators, H. L. and E. B. Woodward, J. H. Mountain.

HIGHWAYS.

Connecticut.—The Stone Road Construction Co. has been organized by E. W. Dewhurst, C. E. Williams and Wm. E. Parker, to build the macadam road from Bridgeport through Long Hill Capital stock, $6,000.

Pennsylvania.—Upper Darby township has again voted in favor of issuing bonds of $15,000 for telford and macadam work on the roads. About 20 miles will be built this year and 20 miles in 1892. Springfield township will take a vote July 23 on the issue of bonds for road work.

Tennessee.—The East Tennessee Land Co. may build a public road from Harriman to Crossville.

Kentucky.—A vote will be taken next month in Warren Co. on the issue of an additional sum of $30,000 for work on turnpike roads. Great benefits are said to have been obtained from the money already spent in this way.

Montana.—A wagon road 35 miles long, between Snead and Lake City, on the Kootenai River, is projected. The work will be done under the Missoula Co. Commissioners.

Washington.—The Whatcom Co. Commissioners have decided to build a plank road from Whatcom to Ferndale, via the Guide Meridian road. The grade of the Guide Meriden road to Lynden will soon be ready for the plank. The Commissioners propose to build several good trunk roads through the county. The Northeast Diagonal road to the forks of the Nooksack River will soon be improved.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Newark, N. J.*—The War Department has approved plans for a bridge across Newark Bay, N. J., for the Jersey City, Newark & Western Ry. Co. It is to have two draw openings, each 100 ft. wide in the clear, and the draw spans are to be 8 ft. 5¾ ins. above mean high water. The Government demanded 25 ft. originally, as was decided in the Baltimore & Ohio bridge over Arthur Kill.

Elizabeth, Pa.—The Pennsylvania R. R. Co. will build a wagon bridge over the Monongahela River at Elizabeth it is stated. The surveying is being done now.

Anne Arundel Co., Md.—The County Commissioners will build an iron bridge over the Patuxent River. It will be 145 ft. long and 12 ft. wide.

Columbus, Ohio—Bids will be received until July 30 for building a bridge across the Olentangy River. The bridge will be a single span of 200 ft. through bridge, double intersection, whipple truss, inclined end posts, 14 panels 14 2-7 ft., height of truss 30 ft. The abutments are at right angles to the line of the bridge. There will be one roadway of 36 ft. and two sidewalks of 6 ft. each, parallel upper and lower chord. Capacity of floor system 100 lbs. per square foot of floor, and capacity of truss sys 80 lbs. per sq. ft. of floor system.

Bids will also be received for 1,612 perch of sandstone masonry, 1,400 cu. yds. of excavation for masonry, 600 loads of boulders for rip rap, 200 perch of limestone for rip rap, 2,986 cu. yds. broken stone, 56,311 cu. yds. of fill, 100 ft. of 18-in. sewer pipe.

Beverly, W. Va.—Bids will be received until June 24 for constructing an iron bridge over Tygart's Valley River. F. J. Triplett, Beverly.

Atlanta, Ga.—All bids for the Forsyth St. Bridge have been rejected, and new bids will be asked for. The cost of a bridge built according to the plans submitted would have been too much and modified plans will be drawn up

WATER-WORKS.

NEW ENGLAND.

Boscawen and Penacook, N. H.—C. H. Amsden, E. S. Harris, E. E. Graves and others have been appointed a committee on new works.

Franklin Falls, N. H.—Extensions to cost about $5,000 will be made.

Hudson, N. H.—G. O. Sanders informs us that he wishes to buy ⅛ mile of 6 and one mile of 4-in. pipe.

Rochester, N. H.—It is reported that the mains will be extended to East Rochester, and that a stand-pipe will be used.

Whitefield, N. H.—The fire wardens have been authorized to make a 15-year contract for hydrant rental with the Whitefield Aqueduct Co., or any other company, and to pay $2,000 a year. Address B. C. Garland or G. H. Morrison.

Rutland, Vt.—Thomas Regan, of Philadelphia, and B. S. Chew, of Gloucester, N. J., have been awarded the contract for furnishing and laying 14,700 ft. of 16-in. supply main for 37,807

Foxborough, Mass.—Bids will be received by G. F. Williams, Clerk of Water Supply District, until July 27, for building works, including 6¼ miles of cast-iron pipe, well, pumping machinery and stand-pipe. F. L. Fuller, 12 Pearl St., Boston, is engineer.

New Bedford, Mass.—Petitions for mains on several streets have been granted.

Wickford, R. I.—Works are talked of.

East Hartford, Conn.—The following is from Percy S. Bryant, Hartford:

The district has authorized its committee to contract with the East Hartford Water Co., and negotiations are in progress. Four sources of supply are under consideration. Probably a stand-pipe will be used. Estimated cost, $100,000. E. J. McKnight is President. Population of fire district, about 2,500.

MIDDLE.

Amenia, N. Y.—The Amenia Water Co. has been incorporated by Charles Walsh, Georgia Walsh and B. H. Fry.

Buffalo, N. Y.—A 20,000,000-gall. pumping engine may be bought.

Cattaraugus, N. Y.—W. J. Weed, Town Clerk, informs us that E. L. Johnson is President and L. H. Northrup Treasurer of the new water company.

Johnstown, N. Y.—Work will soon be started on a reservoir estimated to cost $7,000.

Mechanicsville, N. Y.—Surveys for works are being made.

Southampton, N. Y.—It is reported that a water company will be formed.

Union, N. Y.—Construction of works has been started.

West Carthage, N. Y.—Works to be owned by a company are projected.

Whitestone, N. Y.—Application has been made for an injunction against the issuance by the Commissioners of $45,000 of water bonds.

Cranford, N. J.—A public meeting was held July 16 to consider the construction of works. A state charter, granted in 1870, is said to be still valid, and subscriptions for stock are solicited.

Butler, Pa.—The following is from F. J. Klingler, Trustee:

The Mutual Water Association proposes to supply its members with water for fire and domestic purposes. Thus far all members live in the section of the city called Springdale. An 8-in. well 500 ft. deep has been sunk on a hill 280 ft. above the city, and a tank will be erected and mains laid. Estimated cost, $13,000. Contracts will probably be let Aug. 1.

Knoxville, Pa.—Works are projected. C. F. Billings, Elmira, N. Y., is interested.

Mansfield, Pa.—A $50,000 works is projected by outside parties.

Nescopeck, Pa.—We are informed that the Nescopeck Water Co. has been incorporated, with S. P. Hanley, President, and F. H. Eaton, Berwick, Treasurer; capital stock, $5,000, of which $2,500 is paid in.

Reading, Pa.—At an election July 14 it was voted to issue $150,000 of bonds for the laying of larger mains and connecting the Maiden Creek pumping station with the Hampden reservoir.

Sellersville, Pa.—Works are wanted.

Susquehanna, Pa.—The New York, Lake Erie & Western Ry. Co., it is reported, is negotiating for the purchase of Fox's Pond, 5 miles distant, to supply its shops and locomotives. It is hoped that an arrangement for a village supply can be made.

Washington, D. C.—A main 20 to 12 ins. in diameter will be laid to Anacostia at an estimated expense of $37,000.

SOUTHERN.

Mannington, W. Va.—F. R. Stewart, President, informs us that the Mannington Water Supply Co. proposes to build fire protection works at a cost of from $5,000 to $10,000. Water will be pumped from Buffalo Creek to tank. Population, 2,000.

Statesville, N. C.—C. H. Armfield, Mayor, has sent the following:

The Aldermen have been authorized to pay an annual hydrant rental of $3,000 for 50 hydrants to any company who will build works. In the near future bids will probably be asked. The supply will be pumped from a creek 2½ miles distant to a stand-pipe. Estimated cost, $2,500; population, 3,000.

Atlanta, Ga.—The commissioners have awarded the contract for three 10,000,000-gall. pumping engines to the Holly Manufacturing Co. for $154,000. The award had not been confirmed by the Council at last reports.

South Jacksonville, Fla.—The South Jacksonville Water Works Co. has been incorporated by B. S. Partridge, C. E. Garner and others; capital stock, $5,000. The supply will be from an artesian well. About 6,000 ft. of mains are proposed.

Huntsville, Ala.—E. R. Hartford, Chattanooga, has recommended the purchase of new pumping machinery and a stand-pipe.

Selma, Ala.—The company has bought two artesian wells at Mullen's Lake and will lay a supply main therefrom.

Plaquemine, La.—The Mayor informs us that contracts for works will probably be let about Aug. 1. There will be a 12×100 ft. stand-pipe.

Port Gibson, Miss.—A press dispatch states that a franchise has been granted and a company to be called the Holly Water-Works Co. will be organized. About 1½ miles of mains will be laid and 17 hydrants placed. The supply will be from infiltration wells near Bayou Pierre. The works must be completed by March 7.

Lexington, Ky.—A report on the enlargement of the impounding reservoir will be made by B. S. Church, New York.

Smith's Grove, Ky.—We are informed that the projected private works are estimated to cost $10,000, and that pumping to a reservoir is proposed. Address S. L. Casey or W. F. Storm. Population, 400.

NORTH CENTRAL.

Fayette, O.—It is reported that a large reservoir is to be built here.

Greenville, O.—Works are projected at an estimated cost of $50,000.

Hillsborough, O.—E. Carson informs us that works are under investigation by the Council, but no definite steps have yet been taken.

Niles, O.—Thomas Connell, Youngstown, has been awarded the contract for works.

Nappanee, Ind.—It is reported that works will be built at a cost of $10,000.

Buchanan, Mich.—A vote was taken July 17 on the issuance of $50,000 of bonds for water-works and a water power dam across the St. Joseph River.

Port Huron, Mich.—Bids will be received by J. T. O'Neill, President Water Commissioners, until July 27, for laying a 20-in. main beneath Black River.

Chicago, Ill.—The Finance Committee of the Council has appropriate $20,000 for driving a 200- and a 600-ft. connecting tunnel, 6 ft. in diameter.

Elgin, Ill.—Bids are wanted until Aug. 4 by the Trustees of the Illinois Northern Hospital for a 100,000-gall. stand-pipe. H. J. Brooks is Superintendent.

Paw Paw, Ill.—It is proposed to pump water from a well to a tower.

Metropolis, Ill.—F. A. Trousdale, Chairman Water-Works and Electric Light Committee informs us that plans for works are being made by G. C. Morgan, Chicago, and that bids will soon be asked for constructing both water works and electric lighting plants.

Tomahawk, Wis.—It is reported that $16,000 have been voted for works. A. J. Olsen is City Clerk.

NORTHWESTERN.

Sheldon, Ia.—H. W. Conant, Clerk, informs us that a franchise for works has been granted.

Luverne, Minn.—Owing to a defect in the call for the election which recently voted bonds for works, another election will be held in August.

Northfield, Minn.—M. M. Clark informs us that preliminary plans for works are being made.

Worthington, Minn.—Six per cent. water bonds to the amount of $15,000 have been sold at par. Material for construction is arriving.

Lexington, Neb.—F. C. May, Clerk, informs us that bonds for works have been issued but not sold.

Ponca, Neb.—S. B. Stough informs us that bonds for works have been voted and are being offered for sale until the last of July. If the bonds are sold bids for building works will be asked.

Casper, Wyo.—O. K. Garvey informs us that contracts for public works estimated to cost $10,000 will probably be let in August. Water will be pumped from a river to a tank. Population, 500.

SOUTHWESTERN.

Brookfield, Mo.—W. D. Crandall informs us that the Council has under consideration an ordinance providing for a popular vote on the issuance of $25,000 of bonds for works.

Batesville, Ark.—I. E. Rosebrough, Recorder, informs us that the franchise granted J. W. Hamilton was forfeited last March. Works are wanted, but nothing is now being done to secure them.

Helena, Ark.—J. O. Bagwell, Clerk, has sent the following:

The Council will grant a franchise to the first party applying who will put up $5,000 forfeit, put in 6½ miles of mains and accept $3,000 a year for about 80 hydrants.

Fort Worth, Tex.—The plans for new works submitted by the American Water-Works Co. provide for a supply from artesian wells at an estimated cost of about $1,000,000. Water will pass from the wells to a reservoir and thence to the pump-well. A 20×130-ft. stand-pipe is included in the plans. The Fort Worth *Mail* states that in case artesian water is not secured 24 storage reservoirs are projected, each to have a capacity of 50,000,000 galls., to be filled from Clear or West Fork.

McGregor, Tex.—The McGregor Artesian Water Co. has sent the following:

One flowing well has been completed and another well is nearly so. The company wishes to issue $10,000 in bonds to raise money to put in mains and a stand-pipe. Population, 1,500.

Waco, Tex.—The Bell Water Co. will sink another well and make other improvements. An issue of $100,000 of 6% bonds will be made.

Lyons, Colo.—E. S. Lyons informs us that works are badly needed, as water is now distributed in barrels. The village is incorporated and can give a good franchise.

PACIFIC.

Seattle, Wash.—Bids are wanted for a 5,000,000-gall. pump. Address Secretary Board Public Works.

Snohomish, Wash.—The Council has rejected all proposals for a franchise, and wishes to secure plans for works to be owned by the town.

Tacoma, Wash.—On Aug. 14 the people will vote on the issuance of $1,500,000 water and light bonds.

Dallas, Ore.—There is talk of granting a franchise to a San Francisco party.

Gilroy, Cal.—An election will be had to vote on the issuance of $50,000 of bonds for the reconstruction of the works.

Woodland, Cal.—The city has accepted plans and specifications for works made by W. T. Garratt & Co., San Francisco, proprietors of an iron foundry. The plans provide for three 10-in. wells 200 ft. deep, two boilers, two pumps, four 37,000-gall. tanks, about 7 miles of 12 to 4 in. pipe and 23 hydrants. Estimated cost, $50,000 or less. The city is now supplied by a company.

Moscow, Ida.—Bids are wanted by J. W. Lienallen, City Clerk, until July 27 for a 14×80-ft. stand-pipe; also for furnishing and laying 12,000 ft. of 6 and 7,000 ft. of 4-in. mains and setting 23 hydrants.

CANADA.

Pembroke, Ont.—The issuance of $50,000 bonds for works is proposed.

Neepawa, Man.—A. M. White informs us that contracts for works will be let July 18. There will be a reservoir. Estimated cost, $8,000. Population, 1,200.

Vancouver, B. C.—The city proposes to buy the company's works and has chosen Hermann Schussler, San Francisco, as its arbiter. The company has chosen I. W. Smith, Portland, Ore.

ARTESIAN WELLS.

Macon, Ga.—The water company has begun work on a system of wells by the river, three miles from Macon.

Keokuk, Ia.—An Artesian Well Co. has been organized; capital, $10,000.

White Lake, S. Dak.—Four wells will be sunk by the Rust Artesian Well Co., Ithaca, N. Y.

IRRIGATION.

Cozad, Neb.—A citizens' meeting was recently held to confer with a committee from Lexington and C. W. Aldrich, of the Kansas Loan & Trust Co., Denver, regarding the building of a canal through a part of the Platte Valley.

Biggs, Cal.—It is reported that the Feather River Canal Co. will soon let the contract for digging 7,700 ft. of canal near Biggs. It is proposed to divert water from the Feather River about two miles below Oroville. T. R. Fleming is Superintendent.

New Companies.—Mountain View Reservoir Co., Loveland, Col., $50,000; La Plata Ditch Co., La Plata, N. M., $425,000; J. T. Hobbs, F. V. Williams and others; to extend Williams' ditch in San Juan Co. to cover mesa lands five miles distant; Bear Lake Land & Water Co., San Francisco, Cal., $1,000,000; St. Anthony Canal Co., St. Anthony, Ida., $150,000; J. H. Bacon, President, Salt Lake City, Utah; irrigate from Snake River.

SEWERAGE AND MUNICIPAL.

Sewers, Maine.—Belfast. The Sewer Committee has been directed to ascertain what extent of sewer work will be required this year.

Vermont.—Burlington. The Street Commissioners have arranged with Mr. F. P. Stearns, Engineer to the Massachusetts State Board of Health, to inspect the sewerage system.

Massachusetts.—Lynn. The contract for the western intercepting sewer has been awarded to the National Construction Co., of Boston, for $31,340.—Boston. The city engineer has asked for an appropriation of $240,472 to complete the improved sewerage system.

Rhode Island.—Providence. An appropriation of $75,000 has been made for additional sewers.—Pawtucket. A report in favor of sewage disposal by filtration or filtration and irrigation has been made to the Sewer Commissioners by Messrs. S. N. Gray and C. A. Allen.

New York.—Hornellsville. A sewer commissioner has been appointed who will have charge of the investigation of the proposed sewerage system.—Far Rockaway. The sewerage and drainage plans have been disapproved by the State Board of Health, as they do not provide for a system of disposal to avoid the deposit of sewage on the flats.

New Jersey.—Bridgeton. A survey is to be made for the new sewerage system.—Weehawken. The Council has taken steps toward the establishment of a sewerage system.—South Orange. A citizens' committee has been organized to aid in the establishing of the sewerage system; H. A. Mandeville, George B. Turrell and W. F. Allen are on the committee.—Washington. The New York Sanitary Sewer Co. has made a proposition to put in sewers.

Alabama.—Mobile. The Mobile Sewerage Co. has been incorporated by G. R. Gage, J. K. Glennon and P. L. Lyons, of Mobile, and J. E. Lewis, of New York.

Michigan.—Ann Arbor. A committee has been appointed to examine the sewerage systems of Jackson and Kalamazoo.

Illinois.—Freeport. The Council has engaged Mr. Arthur Lagron, of Rockford, to prepare plans and specifications of the sewer system.

Iowa.—Des Moines. The City Engineer has prepared plans for sewers for North Des Moines.

Missouri.—Springfield. Mr. Johnson is preparing plans for sewer work, and contracts will probably be let soon.

California.—Ukiah. A sewerage system is projected.

Streets.—*Massachusetts.*—Cambridge. The Aldermen have appropriated $10,000 for repairing streets.—Brockton. The city will spend about $100,000 on street work.

New York.—Greenwich. Main St. is to be macadamized.

Pennsylvania.—Johnstown. About $50,000 will be spent on brick paving and street improvements.—Reading. Belgian block paving is to be laid on Perkonier Ave.—Coatesville. The Council has decided to spend several thousand dollars on granolithic sidewalk paving.

Bonds.—Huntington, W. Va.; $70,000 for paving, $12,000 for sewers; bids received July 31 by the Finance Committe. Springfield, Mass.; $70,000 sewer bonds sold to Blake Bros. & Co., of Boston. Springfield township, Delaware Co., Pa.; $80,000 for roads. North Yakima, Wash.; $50,000 for sewers. Yavapai Co., Ariz.; $153,000; bids received Aug. 4, by E. J. F. Horne, Clerk of Board of Supervisors, Prescott, Ariz. Winona, Minn.; bids wanted for $25,000 water-works, $20,000 sewer and $100,000 bridge bonds. Shoshone Co., Idaho; $300,000; bids received until Sept. 15, by G. B. N. Hillard, Clerk of Board of Commissioners, Murray, Idaho. Pawtucket, R. I.; $75,000 for sewers. Ukiah, Cal.; $25,000 for sewers.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable in the following places: Riverside, Tex.; St. Bernard, La.; Washburn, Wis., address A. C. Probert; Rawlins, Wyo., address Dr. J. E. Osborne; Wilmington, O.; Hamilton, O.; Le Mars, Ia., address J. W. Winchell; Wheeling, Pa., address the Ætna Mill Co.; Sullivan, Ind.; Ensenada, Cal.; Georgetown Tex., address John Steele; Toledo, O., address the Toledo Electric Co.; Seymour, Ind., address W. H. Shields; Quanah, Tex., address J. J. Combs; Wiconisco, Pa., address the Williams Valley Electric Light, Heat & Power Co.

High Point, N. C.—At a recent meeting of the City Council E. A. Snow and J. E. Cox were appointed a committee to purchase a municipal lighting plant.

New Companies.—National Gas & Water Co., Chicago, Ill.; capital stock, $500,000; incorporators, C. D. Hank, E. E. Morrell, N. E. McClary; to operate gas, water and electric works. Solar Incandescent Lamp Co., Chicago, Ill.; capital stock, $300,000; incorporators, M. L. Coffeen, G. R. Mitchell, C. H. Wells. Columbian Electric Works, Chicago, Ill.; capital stock, $3,000,000; incorporators, S. E. Moore, L. S. Day, J. Irvine. Empire Electric Co., Chicago, Ill.; capital stock, $1,000,000; incorporators, C. E. Gaylord, C. N. White, M. J. Frost. World's Incandescent Lamp Co., Chicago, Ill.; capital stock, $100,000; incorporators, G. W. Waite, M. M. Tilton, J. H. Park. Poland & Minot Water, Electric Light & Power Co., Mechanic Falls, Me.; capital stock, $25,000; directors, J. Hanscom, L. Perkins, A. E. True, N. Q. Pope, J. M. Libby. Waynesboro (Va.) Street Railway, Light & Water Co.; capital stock, $100,000; incorporators, W. N. Fishburne, R. G. Wright, W. B. Gallaher and others. Herzog General Electric Co., Newark, N. J.; capital stock $1,000,000; incorporators, F. B. and P. Herzog, of New York; G. G. Frelinghuysen, of Newark. Carolina Light & Power Co., Aiken, S. C.; capital stock, $20,000; incorporators, B. F. Turner, H. Hahn, F. B. Henderson and others. Armour Electric Light, Fuel & Power Co., Chicago, Ill.; capital stock, $5,000,000; incorporators, W. L. Armour, M. C. Burt, A. T. Bennett, C. O. Scudder. Economic Light & Power Co., Charleston, S. C.; capital stock, $100,000; incorporators, W. St. J. Jervey, C. C. Miller, W. E. Holmes. National Electric Co., Alexandria, Va.; capital stock, $1,000,000; President, P. Mason; Secretary, W. J. Dante. Edison Light & Power Co., San Francisco, Cal.; capital stock, $3,000,000. Topeka Water & Electric Power Co., Topeka, Kan.; capital stock, $500,000. Delhi (N. Y.) Electric Co.; capital stock, $30,000. River Falls (Wis.) Light, Heat & Power Co.; capital stock, $80,000; incorporators, F. J. Burhyte, R. N. Jenson, W. W. Thayer and others. Franklin (Ind.) Water, Light & Power Co.; capital stock, $100,000; secretary, M. L. Johnson.

CONTRACTING.

Sewers.—*Laconia, N. H.*—The contract has been awarded to G. L. Allen, of Worcester, Mass.: 6-in. pipe, 55 cts. per ft.; 8-in., 85 cts.; 10-in., $1.15; 12-in., 95 cts.; 15-in., $1.70; 12 and 15-in. outlets, $1 and $1.50; branches, 34 cts. for 6-in., 55 cts. for 8-in., 77 cts. for 10-in., $1 for 12-in., $1.41 for 15-in.; 3, 4 and 6 in. tile, 10, 12 and 20 cts.; flush tanks, $70 and $190; manholes, $45; inspection holes, $25; lampholes, $2; rock, $4.50. Mr. W. H. Chapman is the engineer in charge.

Wilmington, Del.—Contracts have been awarded as follows: Prices Run, C. Raymond Weaver, Baltimore, Md.; 6-ft. sewer, $10.65; 6-in. slants, $30; manholes, $25; rock excavation, $1.45. Market St.: C. R. Weaver; 8, 12, 15 and 18-in. pipe, 56, 72, 87 and 104 cts.; 8, 12, 15 and 18-in. Ys, 83 cts., $1.45, $2.17, $2.87; inlets, $24.45 to $45; manholes, $40; lampholes, $20; rock excavation, $1.45; traps, $13.50. Jackson St., Lovering Ave. and Van Buren St.: C. R. Weaver; 30 × 45 ins., $3.54; 25 × 39 ins., $3.40; 24 × 36 ins., $2.35; 20 × 30 ins., $2; slants, 30 cts., inlets, $24.45 to $45; junction manholes, $45; rock excavation, $1.70; traps, $10.50; vitrified brick, $29.75, per 1,000 laid. Shipley Run: John Jacoby, Wilmington; 108 × 114 ins. to 123 × 109½ ins., $36.50; 108 × 114 ins., $16.30; 12 ft. invert, $5.50; inlets, $65 and $90; manholes, $90. Clements Run: J. McPartland, Philadelphia, Pa.; 54 × 54 ins., $8; 38 × 56 ins., $6.50; 32 × 48 ins., $6; 30 × 45 ins., $5.50; 28 × 42 ins., $4; 24 × 36 ins., $3.25; 22 × 33 ins., $2.50; 6-in. slants, 25 cts.; inlets, $40 to $75; junction manholes, $50; rock excavation, $3; traps, $12; vitrified brick, $27 per 1,000 laid. Mr. T. C. Hatton is the engineer in charge.

Street Work.—*Staunton, Va.*—The contract for 4,440 sq. yds. of brick paving has been awarded by Mr. C. H. Harrison, City Engineer, to Mr. A. M. Vals; for repressed round edge paving brick (John Porter Co., New Cumberland, W. Va.) $21.40 per 1,000; paving and ramming, 20 cts. per sq. yd.; taking up old macadam, 40 cts. per cu. yd.; concrete, $3.20 per cu. yd.; sand, $1.10 per cu. yd. Resetting or replacing curbing (furnished by the city), 10 cts. per lin. ft. Other paving of this kind is to be laid. The width of the street is 27 ft.; surface of paving 7 ins. below curb level at gutter and 1 in. at center. The brick is laid upon 2½ ins. of sand and 6 ins. of concrete.

Indianapolis, Ind.—Proposals have been received by the Board of Public Works for paving with different qualities of brick. The prices per front foot for 24-ft. streets were from $4.25 to $4.93 with oolitic curbing; $4.04 to $4.42 with stratified limestone curb; $3.90 to $4.36 with Berea curb.

Lancaster, O.—Proposals have been received for brick paving, ranging from $1 to $1.50 per sq. yd.

Brick.—*Pittsfield, Mass.*—The contract for brick for sewers has been awarded by Mr. Burditch, Chief Engineer to the Board of Sewer Commissioners, to the Brookfield Brick Co., of Worcester, Mass., at $7.65 per 1,000.

Washington, D. C.—The District Commissioners have received the following proposals for vitrified brick: John Robrecht, $18.75 per 1,000; J. M. Mack, $18.73; S. M. Hamilton, $21.50; C. C. McColgan, $23.35; Vitrified Brick Co., $19.90; J. A. Hayden, $18.50; McMahon, Porter & Co., $19.40; Freeman Fireclay Co., $21; F. R. McCann, $19.50.

Excavation.—*Boston, Mass.*—Proposals received by the Water Board for excavating at Basin No. 5, in Ashland, ranged from 30 to 60 cts., 26 to 53 cts., 40 to 95 cts. and 62 cts. to $1.20 per cu. yd. for the four sections of work.

Dredging.—*Montgomery, Ala.*—A contract for dredging in the Mobile River has been awarded to the Alabama Dredging & Jetty Co., at 15 cts. per cu. yd.

PROPOSALS OPEN.

Sewers.—*Hammond, Ind.*—About 8,000 ft. of brick sewer. Plans with the City Engineer. J. B. Woods, City Clerk. July 27.

Grand Forks, No. Dak.—Sewerage system in accordance with the plans of the City Engineer. C. A. Hale, City Auditor. Aug. 15.

Stand-Pipe and Water Mains.—*Moscow, Idaho.*—Stand-pipe 14 × 80 ft. 12,000 ft. of 6-in. and 7,00) ft. of 4-in. pipe; 23 hydrants, etc. J. W. Llenallen, City Clerk. July 27.

Street Work.—*West Bay City, Mich.*—Cedar block paving. Blocks 6 in. long, on board foundation, with cobblestone gutters 4 ft. wide, and 3-in. drain tile. The Board of Public Works. July 23.

Boston, Mass.—Granite block paving. H. H. Carter, Superintendent of Streets. July 21.

Roof.—*Boston, Mass.*—Iron roof for the Representatives' chamber of the State House. Architects, Brigham & Spofford, 27 Mt. Vernon St. State House Construction Committee. July 27.

Machinery.—*Montreal, Canada.*—Machinery and boilers for 2 dipper dredges, 3 floating derricks and 2 land derricks. John Kennedy, Chief Engineer. A. Robertson, Secretary Harbor Commissioners. July 28.

Rails.—*Victoria, B. C.*—Girder rails, 200 tons; tee rails, 300 tons. D. W. Higgins, Managing Director. Aug. 15.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works of Philadelphia, Pa., have delivered 2 freight engines with cylinders 19 × 24 in., and 54 in. driving wheels, to the Savannah, Americus & Montgomery. They are building 3 engines for the Rio Grande Western, and 50 for the New York, Lake Erie & Western, including 5 decapods for the latter. The Rogers Locomotive Works, of Paterson, N. J., are building 20 ten-wheel freight engines for the Illinois Central.

Cars.—The Pullman Palace Car Co., of Chicago, Ill., is building 28 cars for the Baltimore & Ohio. The Harvey Steel Car Co., of Chicago, Ill., has an order for 8 coal cars for the Grand Trunk. The Jackson & Sharp Co., of Wilmington, Del., has built 8 open cars for the New York & Sea Beach. The Peninsular Car Co., of Detroit, Mich., is building 500 freight cars for the Burlington, Cedar Rapids & Northern. Car works are to be built at Beaumont, Tex., and the city will give a bonus of $50,000. The Sessions Passenger Car Co., of Chicago, Ill., has been incorporated to manufacture street cars; E. C. Sessions, H. G. Bird, G. T. Brown; $500,000. The Muskegon Car Co., of Muskegon, Mich., has been reorganized as the West Michigan Car & Machine Co.; C. M. Heald, Grand Rapids; J. J. Howden and W. S. Wood, Muskegon; $250,000.

Railway Station.—It is stated that the Illinois Central will build a new and handsome station at Springfield, Ill.

Brakebeam Clamp.—The Mason Regulator Co., of Boston, Mass., has brought out a new form of clamp for pulling the brakebeams toward the car wheels in order to adjust a new connecting rod to the brakebeam in case of breakage when the car is on the road, or to put on a new brakeshoe. It is claimed to be quicker in operation than the screw clamp generally used.

The King Iron Bridge & Mfg. Co., of Cleveland, O., has completed several heavy locomotive turntables for the Lake Shore & Michigan Southern, a four-span double-track bridge for the New York Central & Hudson River, and a number of spans for other roads.

The National Water Purifying Co., of New York, has a contract from the American Water-Works & Guarantee Co., of Pittsburg, Pa., for a gravity filter plant of 2,000,000 galls. capacity for one of its Western water-works.

The Babcock & Wilcox Co., of New York, N. Y., states that Mr. L. M. Moyes, formerly agent at Philadelphia, Pa., has surrendered the charge of that office and business to the company's new agents, Messrs. C. W. Temple and H. F. DePuy.

Companies.—American Gas Controller & Fixture Co., of Jersey City, N. J.; George Dwight, Jr., Springfield, Mass.; L. Murray, Brooklyn, N. Y.; Cleveland Foote, New York; $200,000. Gate City Contracting Co., of Raton, N. M.; C. A. Fox, S. W. Dorsey and V. E. Heatwood; $25,000. Shenango Valley Steel Co., of New Castle, Pa.; W. E. Reis, Chas. Woodward and L. S. Hoyt; $200,000. Greathead Tunnel & Subway Co., of Jersey City, N. J.; W. J. Barg, East Orange, N. J.; J. K. Creevey, Brooklyn, N. Y.; E. H. Johnson, Greenwich, Conn.; F. J Sprague and S. Sterns, New York, N. Y. Rail Lock Joint Co., of Poughkeepsie, N. Y.; T. J. Swift President; $250,000. Cable Car Coupler Co., of East St. Louis, Ill.; C. S. Baldwin, A. Coble and G. H. Tenbroeck; $1,000,000. Anchor Iron-Bound Curb & Paving Co., of Washington, D. C.; President, E. A. Oldham; Secretary, M. E. Dent; $100,000. Vancouver & Westminster Paving & Improvement Co., of Vancouver and New Westminster, B. C.; to lay asphalt paving; W. C. Sullivan, St. James Timber Co., of New Orleans, La.; to manufacture cross-ties, bridge and trestle timbers, etc.; President, C. M. Green; Manager, J. Brogan; Secretary, W. M. Rhodes. Western Smoke-Preventing Co., of Chicago, Ill.; J. C. Nutting, S. V. Nagel and D. F. Flannery; $50,000.

Metal Market Prices.—*Rails.*—New York: $30 to $30.75; old rails, $20.50 for iron and $17 for steel. Pittsburg: $30; old rails, $22.50 to $23 for iron and $17.50 to $18.50 for steel. Chicago: $31 old rails, $23 to $23.25 for iron and $14 to $16.50 for steel.

Track Materials.—New York: steel angle bars, 1.75 to 1.8 cts.; spikes, 2 to 2.1 cts.; track bolts, 2.7 to 2.8 cts. Pittsburg: splice bars, 1.8 to 1.9 cts. for iron or steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.75 cts. with square and 2.85 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.9 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14.75 to $17. Chicago: $14.75 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York: 4.4 to 4.5 cts. Chicago: 4.25 to 4.35 cts. St. Louis: 4.22½ cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.95 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2.05 cts.; sheared steel bridge plates, 2.1 to 2.15 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.1 cts. for tank, 2.4 cts. for shell, 2.6 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.1 to 2.15 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.15 to 2.2 cts.; sheared plates, 2.3 to 2.4 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.4 to 2.6 cts. for tank, 2.85 cts. for shell, 3 to 3.25 cts. for flange; 4.5 to 5.5 cts. for firebox; boiler rivets, 4.25 cts.